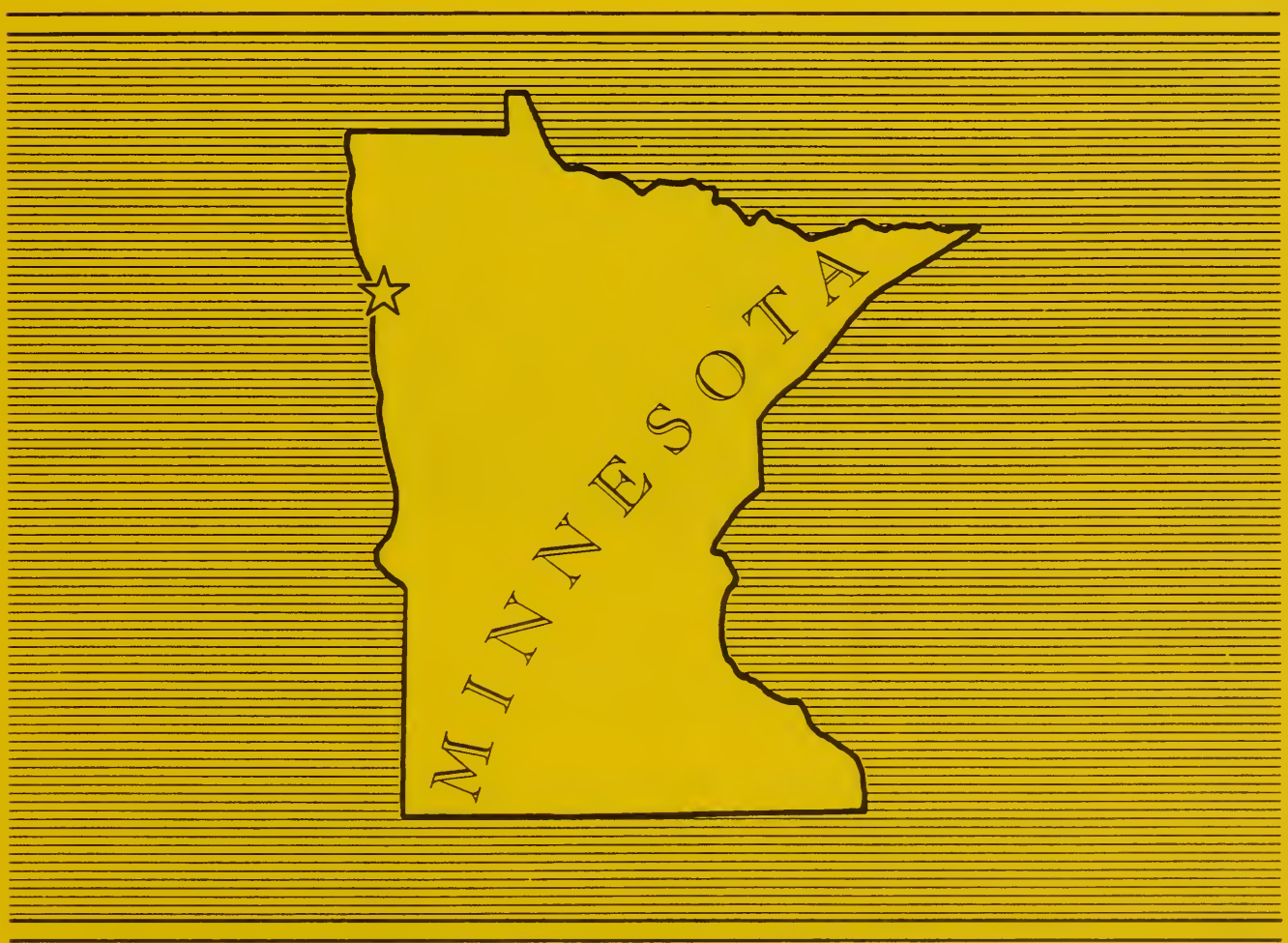
K PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

NORMAN–POLK WATERSHED

Norman and Polk Counties
Minnesota



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

OUR SOIL ★ OUR STRENGTH

USDA SCS LINCOLN NEBR 1971

WATERSHED WORK PLAN AGREEMENT

Between the

East Agassiz Soil and Water Conservation District
Local Organization

West Polk Soil and Water Conservation District
Local Organization

Norman County Board of Commissioners
Local Organization

Polk County Board of Commissioners
Local Organization

Wild Rice Watershed District
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Minnesota

and the

Soil Conservation Service
United States Department of Agriculture

(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Norman-Polk Watershed, State of Minnesota, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service, a mutually satisfactory plan for works of improvement for the Norman Polk Watershed, State of Minnesota, hereinafter referred to as the watershed work plan, which is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about six years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire with other than Public Law 566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated Cost $238,200.)

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The cost of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Relocation Payment Costs (Dollars)
Relocation Payments	41.4	58.6	----------

Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Construction Cost (Dollars)
Grade Stabilization Structure S-1A	40.9	59.1	1/ 53,000
Channel Work and All Other Grade Stabilization Structures	5.0	95.0	1,021,600

1/ Includes non-project cost for road purpose.

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Engineering Costs (Dollars)
Grade Stabilization Structure S-1A	25	75	1/ 12,000
Channel Work and All Other Grade Stabilization Structures	-0-	100	118,000

1/ Includes non-project cost for road purpose.

6. The Sponsoring Local Organization and the Service will each bear the costs of project administration which it incurs, estimated to be $29,300 and $141,200 respectively.

7. The Sponsoring Local Organization will obtain agreements with landowners to carry out conservation plans on not less than 50 percent of the land affecting the structural measures and have at least 50 percent of the land adequately treated before Public Law 83-566 funds are released for construction.

8. The Sponsoring Local Organization will provide assistance to the landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the

reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties.

14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964, as amended, and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any activity receiving federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorized assistance.

County of Norman
Local Organization

By Sanford Jenson

Title Chairman

Ada, Minn. 56510
Address Zip Code

Date 2-14-75

The signing of this agreement was authorized by a resolution of the governing body of the County of Norman
Local Organization

adopted at a meeting held on 2-14-75.

Marlyn Aronson Deputy auditor
Secretary, Local Organization

Ada, Minn. 56510
Address Zip Code

Date 2-14-75

Wild Rice Watershed District
Local Organization

By Emmanuel Dahlsad

Title President

Ada, Minn. 56510
Address Zip Code

Date Feb. 12, 1975

The signing of this agreement was authorized by a resolution of the governing body of the Wild Rice Watershed District
Local Organization

adopted at a meeting held on Feb 12, 1975.

George Scheyen Jr
Secretary, Local Organization

Ada, Minn. 56510
Address Zip Code

Date Feb 12, 1975

County of Polk
Local Organization

By Lloyd Wold

Title Chairman

Crookston, Minn. 56716
Address Zip Code

Date FEB 19 1975

The signing of this agreement was authorized by a resolution of the governing body of the County of Polk
Local Organization

adopted at a meeting held on FEB 19 1975.

Secretary, Local Organization

Crookston, Minn. 56716
Address Zip Code

Date FEB 19 1975

West Polk SWCD
Local Organization

By Edward Thuneck

Title Chairman

Crookston, Minn. 56716
Address Zip Code

Date Feb. 19, 1975

The signing of this agreement was authorized by a resolution of the governing body of the West Polk SWCD
Local Organization

adopted at a meeting held on Feb 19, 1975.

Leslie E Haanes
Secretary, Local Organization

Crookston, Minn. 56716
Address Zip Code

Date Feb 19, 1975

East Agassiz SWCD
Local Organization

By Lowell Moen

Title Chairman

Twin Valley, Minn. 56584
Address Zip Code

Date Feb. 11, 1975

The signing of this agreement was authorized by a resolution of the governing body of the East Agassiz SWCD
Local Organization

adopted at a meeting held on Feb. 11, 1975.

Valley Bernhardson
Secretary, Local Organization

Twin Valley, Minn. 56584
Address Zip Code

Date Feb. 11, 1975

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

Approved by:

State Conservationist

2-20-75
Date

ADDENDUM

NORMAN-POLK WATERSHED

WORK PLAN

Norman and Polk Counties, Minnesota

June, 1974

This addendum was prepared to meet interim requirements of the October 31, 1973, "Principles and Standards for Planning Water and Related Land Resources" of the Water Resources Council.

It includes the following three elements:

1. Benefit-Cost Relationship
2. Abbreviated Environmental Quality Plan
3. Display of Accounts

Benefit-Cost Relationship

This addendum shows construction costs based on 1973 prices. Costs are amortized for 50 years at 5-7/8 percent interest.

Benefits are based on adjusted normalized prices for agricultural commodities.

Annual project benefits are $163,200. Annual project benefits without secondary are $146,600. Annual project costs are $121,300.

The benefit-cost ratio including secondary benefits is 1.3:1. The benefit-cost ratio not including secondary benefits is 1.2:1.

ABBREVIATED ENVIRONMENTAL QUALITY PLAN

Improvement in the quality of life can be achieved with water and land resource developments directed at improving the quality of the environment. The objective in formulating this abbreviated plan was to emphasize the environmental quality aspects within the Norman Polk Watershed.

Environmental Problems

The watershed has a limited variety of scenery and natural beauty. Land use patterns do not allow a great amount of varied scenery. Only 10 percent of the watershed is in land uses other than cropland. The nearly level topography and the lack of lakes, perennial streams, or major natural watercourses result in few scenic areas. Few opportunities exist for enjoyment of outdoor recreational activities.

The habitat is sufficient to support only small populations of wildlife species. Pheasants, sharptail grouse, greater prairie chicken and songbirds occur in small numbers. The future of the greater prairie chicken is considered threatened in Minnesota. Waterfowl usage is minimal because of the lack of water areas. Furbearer habitat is limited and is of poor quality. White tail deer population is small due to the lack of woody winter cover.

Geological, archeological and historical resources are known to exist which have a potential for enjoyment by society. These need to be protected and made accessible to the public. Possibilities of additional unknown resources of these types may also exist. They could be damaged or even destroyed unless provisions are made for their identification and protection. Professionals need to evaluate the watershed to identify these resources. They also need to be protected and made accessible for the enjoyment of society.

Water quality in the Red River is being reduced by sediment and associated nutrient enrichment and pesticides present in the runoff from the watershed. An estimated 37,500 tons of sediment are deposited annually into the Red River.

Land damage is limited primarily to streambank erosion and bank slumping in the constructed ditches at their outlets into the Red and Marsh Rivers. Land damage to a lesser degree from streambank erosion is occurring at the outlets of field ditches as they enter the ditch mains and laterals. Wind and water erosion is a problem in the watershed.

Wind erosion affects the quality of air. Airborne dust is widespread during periods of high winds. This is especially true in the spring due to wind erosion on fields which have been excessively tilled in late fall under dry field conditions.

Component Needs

Component needs include the following:

1. Establish areas of natural beauty and scenic values with diverse areas of vegetation.
2. Develop more outdoor recreation areas.
3. Establish and manage wildlife habitat areas.
4. Investigate and evaluate geological, archeological, and historical resources and preserve those of value.
5. Improve water, land, and air quality by controlling erosion, sedimentation, and associated fertilizer and pesticide pollutants.

Elements of Environmental Quality Plan

The environmental quality plan includes the following elements:

1. Establish an additional 200 miles of single row field windbreaks and 50 miles of multiple row field windbreaks throughout the watershed. Estimated cost of installation is $240,000 including $170,000 land rights cost and $70,000 tree planting cost.
2. Establish a corridor varying in width along 20 miles of existing channels. Revegetate with herbaceous cover and shrubs possessing scenic and wildlife values. Provide public accesses to the corridor. Estimated cost is $95,000 including $70,000 for land rights and $25,000 for seeding and planting.
3. Convert 1,000 acres adjacent to the Marsh and Red Rivers to forest land and 100 acres of cropland having very severe limitations for crop production to woody and herbaceous cover. Provide public accesses to these areas. Estimated cost is $375,000, including $265,000 for land rights and $110,000 for seeding and planting .
4. Restore 200 acres of wetlands and 300 acres of native grasslands for wildlife habitat. Estimated cost is $160,000 including $125,000 for land rights and $35,000 for seeding and developing.
5. Establish wildlife food and cover during winter season on 40 acres of cropland per section or a total of 4,000 acres in the watershed. Landowners will leave 1 acre of crop unharvested and all the crop residues on the surface of each 40 acre tract per section until the following spring. Fall plowing will be discontinued on these areas. Educate landowners to use proper

crop residue management on the remaining cropland areas Estimated cost is $340,000 for land rights.

6. Landscape areas along 12 miles of major highways by establishing plants and shrubs possessing natural beauty. Estimated cost is $5,000 including $3,500 for land rights and $1,500 for planting and seeding.
7. Develop management plans and properly manage all the forest lands, wetlands, and native grasslands for timber production, wildlife, and scenic values. Estimated cost for technical assistance is $25,000 annually.
8. Establish a road wayside area along one of the major highways which would be kept in a climax range condition. Establish a marker describing the natural process in reaching and maintaining climax range conditions. Estimated cost is $1,500.
9. Develop a trail system on some of the beach ridges adjacent to the major roads. Establish markers describing the origin of these ridges and the features to observe along the trails. Estimated cost is $5,000.
10. Establish markers locating the geological, archeological and historical resources. Develop marker in honor of John Shelly, the early settler in whose honor the community of Shelly is named. Develop markers honoring the locally significant Lockhart Farm and describing the remaining evidences of Glacial Lake Agassiz. Preserve the area and develop marker for the mound (Site No. 21 PLS) in the NE$\frac{1}{4}$ of section 33, T147N, R45W. Estimated cost is $3,500.
11. Apply needed conservation land treatment practices on the cropland presently subject to erosion and sedimentation damage. Such measures as conservation cropping system, minimum tillage, crop residue management, and grade stabilization structures will be applied at an estimated cost of $600,000. Present land treatment will be continued on the adequately treated areas.
12. Install grade stabilization structural measures near the outlets of drainage ditches into the Red and Marsh Rivers estimated to cost $650,000. Construction is estimated to cost $500,000 and engineering and administrative service to cost $150,000. Annual operation and maintenance cost will amount to $5,000.
13. Improve the application techniques of fertilizers and pesticides throughout the watershed. Estimated cost for educational activities is $20,000.
14. Implement a comprehensive land and water use plan for Norman and Polk Counties. Identify and protect environmentally sensitive areas including those having historical and scenic values. Provide guidance for the development of sewage and

waste treatment facilities. Estimated cost of portions of the counties in Norman-Polk Watershed is $5,000.

A capital investment of $2,500,000 and an annual operation, maintenance, and management cost of $30,000 will be required for the installation of the EQ Plan. About 90 man-years of labor would be required.

Institutional Arrangements Available and Needed for the Implementation of the Environmental Quality Plan (EQ Plan)

Legal entities of government are in existence for the implementation of the EQ Plan. They include township and county government, joint powers of county government, and soil and water conservation districts, or the Wild Rice Watershed District. All of these have the power of eminent domain and taxation by law.

Several private, state, and federal programs are available providing financial assistance both for land acquisition and for establishment of the measures to implement the EQ Plan, namely:

Private Programs

1. Minnesota Chapter of Nature Conservancy - Acquires and manages lands of high ecological value.

State Programs

1. Minnesota Department of Natural Resources
   a. Forestation Program - Provide tree planting stocks and technical assistance.
   b. Private Land Wildlife Habitat Improvement Program - Provide financial and technical assistance to create wildlife habitat on private lands.
   c. Wetlands Acquisition Program - Acquire and maintain wetland areas.
   d. Natural Resource Funds - Provide financial assistance for developing fish and wildlife habitat and recreational areas.
2. State Planning Agency
   a. Division of Parks and Recreation - Land acquisition and development of recreation facilities.

Federal Programs

1. U. S. Department of Agriculture
   a. Resource Conservation and Development - Financial and technical assistance whenever the watershed becomes part of a RC&D Project.

b. Water Bank Act - Provides compensation to landowners for maintaining wetlands.
c. Rural Environmental Conservation Program - Provides cost-sharing assistance to individual landowners for application of conservation practices.
d. Loans and Advances - Provides loans and advances to sponsoring organizations.

2. U. S. Department of Interior
   a. LAWCON Funds - Provides financial assistance for developing fish and wildlife habitat areas when included as part of a recreation project. Administered by the State.
   b. Pitman-Robertson Funds - Provides for wildlife research and financial and technical assistance in developing wildlife habitat areas. Administered by the state.
   c. Small Wetlands Acquisition Program - Acquire and maintain wetland areas.

Technical assistance including educational and on-site assistance is available from:

1. Local Soil and Water Conservation Districts.
2. Agricultural Extension Service
3. Minnesota Department of Natural Resources.
4. USDA including Soil Conservation Service and Forest Service.
5. USDI, Bureau of Sport Fisheries and Wildlife.

In spite of the many available programs for financial assistance higher priorities for the funds exist in other areas of the state and nation. Therefore, additional sources of funds are needed by the local government to implement the EQ Plan.

Norman and Polk Counties need to adopt a land-use policy and provide for the enforcement of the policy.

Environmental Effects of the Environmental Quality Plan

The implementation of the EQ Plan for Norman-Polk Watershed will provide environmental benefits for present enjoyment as well as for future generations.

More variety in natural beauty and more opportunities for human enjoyment will be provided. Establishing a corridor of grasses and shrubs with a meandering borderline will more closely resemble natural stream conditions. Establishing field windbreaks, forested areas, wetlands, native grasslands, and landscaped areas adjacent to roads and ditches, as well as the corridor, will provide a contrast and add to the variety of the natural scenery. Winds will be less noticeable with the planting of additional

trees. Public access to the vegetated corridor and forested areas will add needed outdoor recreation for human enjoyment.

The biological resources will increase in quantity and variety with the establishment of wildlife food and cover areas. This will be achieved by the establishment and management of forests, wetlands, native grasslands and food plots, as well as improved crop residue management on the cropland. This involves approximately 6,700 acres of land plus the cropland receiving the application of improved crop residue management.

The geological, archeological, and historical resources will be located and publicized for the benefit of society.

The application of conservation land treatment practices, installation of grade stabilization structures and improved application techniques in the use of fertilizers and pesticides will reduce nutrient enrichment of the runoff waters entering the Red River. Total sediment deposited annually in the Red River will be reduced from 37,500 to 13,500 tons per year.

Land voiding from streambank erosion and bank slumping presently occurring at the rate of one acre per year will be arrested. Wind and water erosion will be substantially reduced on the cropland presently possessing erosion problems. Reduced wind erosion with improved management of the soil will also reduce the amount of airborne dust and improve air quality.

There will be a slight increase of land in forests and other uses, primarily wildlife habitat, and a corresponding decrease of land in cropland. See table below.

Land Use Patterns with EQ Plan
Norman-Polk Watershed

Item	Crop-land	Pasture-land	Forest Land	Other Land	Total
Present Land Use	65,300	2,200	355	4,645	72,500
Land Use Adjustment	-2,800	-	+1,800	1/ +1,000	-
Land Use with EQ Plan	62,500	2,200	2,155	5,645	72,500

1/ Land converted primarily to wildlife habitat.

Adoption and enforcement of county-wide land-use regulation will identify and protect the environmentally sensitive areas. Guidance would be given on residential, industrial, and agricultural developments so that environmental conflicts can be recognized and resolved.

DISPLAY OF ACCOUNTS

The following system of accounts illustrates a display of beneficial and adverse effects of the selected plan for Norman-Polk Watershed on the components of National Economic Development and Environmental Quality Objectives and on the Regional Development and Social Well-Being Accounts. This is consistent with the Water Resource Council's adopted Principles and Standards.

SELECTED PLAN
NORMAN-POLK WATERSHED
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

COMPONENTS Beneficial Effects	MEASURES OF EFFECTS (Average Annual 1/)	COMPONENTS Adverse Effects	MEASURES OF EFFECTS (Average Annual 1/)
A. The value to users of increased outputs of goods and services		A. The value of resources required for a plan	
1. Flood Prevention	$123,280	1. Grade stabilization structures and channel modifications	
2. Drainage	14,170	Project Installation (structural measures)	$82,310
3. Utilization of unemployed and underemployed labor resources		Project Administration	9,890
		OM&R	22,150
Project construction and OM&R	9,250	Total adverse effects	$114,350
Total beneficial effects	$146,700	Net beneficial effects	$32,350

1/ 50 years at 5-3/8 percent interest

June 1974

SELECTED PLAN
NORMAN-POLK WATERSHED
ENVIRONMENTAL QUALITY ACCOUNT

COMPONENTS	MEASURES OF EFFECTS
Beneficial and Adverse Effects:	
A. Areas of natural beauty.	1. Change the physical appearance of the area with the application of land treatment practices such as field windbreaks, tree planting, farm ponds, and wildlife wetland habitat management.
	2. Removal of five acres of forest land.
	3. Reduce erosion damage to cemetery and public utilities.
B. Biological resources and ecosystems.	1. Wildlife habitat such as travel lanes, escape cover, food and other types of habitat will be provided with 450 acres of vegetative plantings along the channel side slopes, berms, and spoil banks and along at least 110 miles of field windbreaks.
	2. Existing vegetation will be destroyed in 28 miles of channels disrupting upland game and other wildlife habitat until new vegetation is established. Vegetative plantings possessing wildlife values will be included in the seeding operation. Some wildlife will be destroyed by construction equipment.
C. Quality consideration of water, land, and air resources.	1. Increase land adequately treated from 20,680 to 49,450 acres.

SELECTED PLAN
NORMAN-POLK WATERSHED
ENVIRONMENTAL QUALITY ACCOUNT

COMPONENTS	MEASURES OF EFFECTS
C. Quality consideration of water, land, and air resources (Cont.).	2. Reduce wind erosion from 20 to 4 tons per acre on 12,000 acres.
	3. Reduce annual wind and water erosion from an average of 1.1 to 0.8 ton per acre.
	4. Reduce nutrient (N,P, & K) pollution into the drainage systems.
	5. Reduce sedimentation outflow from 37,500 to 18,000 tons per year.
	6. Reduce land voiding from 1.0 to 0.25 acre per year.
	7. Reduce soil fertility temporarily on 55 acres of spoil bank area.
	8. Increase sediment during construction.
	9. Increase peak discharge into the Red River.
D. Irreversible or irretrievable commitments of resources.	1. Conversion of 252 acres of cropland, 5 acres of forest, and 236 acres of existing channel and grassed spoil banks to new channel, sideslopes, and berms.

June, 1974

SELECTED PLAN
NORMAN-POLK WATERSHED
REGIONAL DEVELOPMENT ACCOUNT

COMPONENTS	MEASURES OF EFFECTS (Average Annual 1/) State of Minnesota	Rest of Nation
Income:		
Beneficial effects		
A. The value of increased outputs and services to users residing in the region.		
1. Flood Prevention	$123,280	-
2. Drainage	14,170	-
3. Utilization of unemployed and underemployed labor resources.		
a. Project construction and OM&R	9,250	-
b. Secondary	16,600	-
Total beneficial effects	$163,300	-

COMPONENTS	MEASURES OF EFFECTS (Average Annual 1/) State of Minnesota	Rest of Nation
Income:		
Adverse effects:		
A. The value of resources contributed from within the region to achieve the outputs.		
1. Grade stabilization structures and channel modifications		
Project installation	$16,870	$65,440
Project administration	1,700	8,190
OM&R	22,150	-
Total adverse effects	$40,720	$73,630
Net beneficial effects	$122,580	-$73,630

1/ 50 years at 5 3/8 percent interest

SELECTED PLAN
NORMAN-POLK WATERSHED
REGIONAL DEVELOPMENT ACCOUNT

COMPONENTS	MEASURES OF EFFECTS	
	State of Minnesota	Rest of Nation
Employment:		
Beneficial effects:		
A. Increase in the number and types of jobs.		
1. Agricultural employment	Utilization of 10 people in part time employment for 3 months in agricultural production	-
2. Employment for project construction	55 skilled and 25 semi-skilled jobs for 1 year	-

COMPONENTS	MEASURES OF EFFECTS	
	State of Minnesota	Rest of Nation
Employment:		
Adverse effects:		
A. Decrease in number and types of jobs.		
1. Loss in agricultural employment of project take area	Utilization of 1 person in part time employment for 3 months in agricultural production	-
Total adverse effects	1 semi-skilled part time job for 3 months	-

SELECTED PLAN
NORMAN-POLK WATERSHED
REGIONAL DEVELOPMENT ACCOUNT

COMPONENTS	MEASURES OF EFFECTS		COMPONENTS	MEASURES OF EFFECTS	
	State of Minnesota	Rest of Nation		State of Minnesota	Rest of Nation
Employment: (Cont.)			Employment:		
Beneficial effects:			Adverse effects:		
3. Employment for project	2 skilled and 2 semi-skilled jobs permanently	-	Net beneficial effects:	9 semi-skilled jobs for 3 months, 2 permanent skilled and 2 semi-skilled jobs, 55 skilled and 25 semi-skilled jobs for 1 year	-
Total beneficial effects	10 semi-skilled part-time jobs for 3 months,	-			-
	2 permanent skilled and 2 semi-skilled jobs,	-			
	55 skilled and 25 semi-skilled jobs for 1 year	-			

June 1974

SELECTED PLAN
NORMAN-POLK WATERSHED
REGIONAL DEVELOPMENT ACCOUNT

COMPONENTS	MEASURES OF EFFECTS	
	State of Minnesota	Rest of Nation
Population Distribution		
Beneficial effects	Creates 9 semi-skilled part-time jobs for 3 months, 2 permanent skilled, 2 semi-skilled jobs, 55 skilled and 25 semi-skilled jobs for 1 year, primarily in an isolated rural area which has experienced a 20 percent reduction in population between 1960 and 1970.	-
Adverse effects	-	-
Regional Economic Base and Stability		
Beneficial effects	Provides for an average increase in farm income of $1,175 for each of 85 land users in an area where agriculture is the major economic activity. Creates 2 permanent skilled and 2 permanent semi-skilled jobs and 55 short-term skilled jobs in an area where 29 percent of the families have incomes of $4,000 or less	-
Adverse effects	-	-

June 1974

SELECTED PLAN
NORMAN-POLK WATERSHED
SOCIAL WELL-BEING ACCOUNT

COMPONENTS	MEASURES OF EFFECTS
Beneficial and Adverse Effects:	
A. Real Income Distribution	1. Create 2 permanent and 34 part-time low to medium income jobs for area residents.
	2. Create regional income benefit distribution of $163,300 annually by income class as follows:

Income Class (Dollars)	Percentage of families in each income class	Percentage of benefits to accrue to each class
Less than 4,000	29	10
4,000-12,000	58	55
More than 12,000	13	35

3. Local costs of $40,720 to be borne annually by the region with distribution by income class as follows:

Income Class (Dollars)	Percentage of families in each income class	Percentage of contributors in each class
Less than 4,000	29	10
4,000-12,000	58	55
More than 12,000	13	35

SELECTED PLAN
NORMAN-POLK WATERSHED
SOCIAL WELL-BEING ACCOUNT

COMPONENTS	MEASURES OF EFFECTS
Beneficial and Adverse Effects: (Cont.)	
B. Life, Health, and Safety	1. Reduce the hazards of operating farm machinery along vertical side slopes.
	2. Provide flood protection from 5-year-frequency storms (20 percent level).
	3. Provide flood protection from 50-year-frequency storms (2 percent level) to 15 affected bridges and culverts.
	4. Provide for removal of 10 bridges and culverts closing the affected roads.

June 1974

WATERSHED WORK PLAN

NORMAN-POLK WATERSHED

Norman and Polk Counties, Minnesota

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83d Congress, 68 Stat. 666), as amended.

Prepared by:

West Polk Soil and Water Conservation District
East Agassiz Soil and Water Conservation District
Polk County Board of Commissioners
Norman County Board of Commissioners
Wild Rice Watershed District

With assistance by:

U.S. Department of Agriculture, Soil Conservation Service
U.S. Department of Agriculture, Forest Service
U.S. Department of Interior, Bureau of Sport Fisheries and Wildlife
Minnesota Department of Natural Resources

June 1974

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WATERSHED WORK PLAN

NORMAN-POLK WATERSHED

Norman and Polk Counties, Minnesota

April 1974

SUMMARY OF PLAN

The Norman-Polk Watershed contains 72,500 acres (113.3 sq. mi.). Of this, 59,000 acres are in Norman County and 13,500 acres are located in Polk County in northwestern Minnesota. The watershed is a direct tributary of the Red River of the North.

The plan for watershed protection, flood prevention, and agricultural water management, is sponsored and developed by the West Polk Soil and Water Conservation District, East Agassiz Soil and Water Conservation District, Polk County Board of Commissioners, Norman County Board of Commissioners, and Wild Rice Watershed District. Technical assistance was provided by the Soil Conservation Service and the Forest Service of the U.S. Department of Agriculture, the Bureau of Sport Fisheries and Wildlife of the U.S. Department of Interior, and the Minnesota Department of Natural Resources.

The principal problem is extensive overbank flooding, on approximately 26,000 acres of agricultural land, affecting 100 farms and 2.9 miles of channel erosion. The lack of adequate surface drainage outlets exists on 8,000 acres. In addition, channel sedimentation is occurring throughout the watershed from wind and water erosion.

The Plan includes land treatment and structural measures consisting of 28 miles of channel work and 6 grade stabilization structures. The land treatment and structural measures will reduce average annual monetary damages by approximately 73 percent on 20,000 acres of flood plain adjacent to judicial ditches 52 and 54, lateral 1, benefiting 85 farms. In addition, they will substantially reduce erosion, channel sedimentation, and sediment outflow from the watershed. Included in the 20,000 acres are 1,600 acres located outside the watershed.

There are 6,000 acres of agricultural land along judicial ditch 53 that receive damages. The runoff from four sections of land will be designed to flow into judicial ditch 52 system, thereby reducing the floodwater volumes in the lower reaches of judicial ditch 53.

Some of the applicable land treatment practices included in the plan are conservation cropping systems, crop residue management, minimum tillage, stubble mulching, and field windbreaks.

The structural measures planned include 28 miles of channel work, six major grade stabilization structures within channels, and numerous grade stabilization structures on side inlets. Channel work includes enlargement of 22.5 miles of previously constructed channels, enlargement of 3.9 miles of existing field ditches, 0.3 mile of new channel work and 1.5 miles of channel stabilization. This channel work is on judicial ditches 52 and 54, lateral 1, systems. There is no planned action on judicial ditches 53 and 54 and county ditch 28.

Wildlife cover will be improved by the establishment and control of a 450-acre vegetative strip along and on each side of the 28 miles of channel improvement. This will more than offset the loss of the limited amount of unmanaged cover along existing ditch banks. The topography of the watershed does not provide opportunities for floodwater detention sites.

The planned project will be installed over a six-year period.

The total project cost is $2,287,500. The Public Law 83-566 share is $1,341,900. The share of the cost from other than Public Law 566 funds (hereinafter referred to as "Other") is $945,600.

Landowners and operators will install and maintain land treatment measures under agreements with their soil and water conservation districts. The total estimated cost of land treatment measures is $697,200. Public Law 83-566 funds amounting to $72,100 will provide technical assistance to accelerate the installation of land treatment measures.

The grade stabilization structures and the channel work will be installed through contracts let by the Wild Rice Watershed District.

The cost of the structural measures is estimated at $1,590,300. The Public Law 83-566 cost of $1,269,800 includes $1,001,600 for construction, $127,000 for engineering, and $141,200 for project administration. The other than Public Law 83-566 costs of $320,500 include $53,000 for construction, $238,200 for land rights, and $29,300 for project administration.

The Wild Rice Watershed District, East Agassiz Soil and Water Conservation District, West Polk Soil and Water Conservation District, Norman County Board of Commissioners, and Polk County Board of Commissioners will assume the responsibility for the operation and maintenance of all structural measures. The estimated average annual operation and maintenance costs of all structural measures is $22,150.

The average annual benefits attributed to the structural measures are estimated to be $163,300 and total average annual cost is $114,350. The resulting benefit cost ratio is 1.4:1.0.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Data

The project is located in northwestern Minnesota in Norman and Polk Counties and has a drainage area of 72,500 acres or 113.3 square miles. There are 59,000 acres (81 percent) in Norman County and 13,500 acres (19 percent) in Polk County.

The watershed is long and narrow, extending from the Red River to the east for about 22 miles, and has an average width of five miles. The major natural watercourses adjacent to the watershed are the Sandhill River on the north and the Marsh River on the south. The watershed itself has no lakes or major natural watercourses. The surface runoff is presently being removed by a series of judicial and county ditches. The watershed is located within the Red River Subregion of the Souris-Red-Rainy Water Resources Region. The water and related land resources in the watershed are similar to the other watersheds in the subregion.

The city of Shelly (population 310) is the only incorporated community within the watershed. The watershed population is estimated at 800 people according to the 1970 census. Fargo-Moorhead, the nearest major trading center, is located about 40 miles south of the watershed. The metropolitan area of Minneapolis-St. Paul is located approximately 250 miles to the southeast.

Soil and water resource characteristics are directly related to the glacial origin of the subregion. In the late stages of the last continental glaciation, about 10,000 years ago, a large inland lake was formed which has been named Glacial Lake Agassiz. The lake covered the entire Red River Valley and extended into Canada. The lake began to shrink in size as the melting ice retreated northward. The shrinking lake margins are preserved to this day by the sand and gravel beach shorelines formed at each successive lower lake level. The succession of beach shorelines are presently referred to as beach ridges. At least three of these beach ridges occur in this watershed. The beach ridges and near-shore sand areas occupy the eastern one-third of the watershed east of State Highway No. 9. These soils are sandy, droughty, and low in inherent fertility. The beach ridge areas are moderately steep, allowing for rapid runoff.

The deeper portions of the glacial lake bottom, in the lower two-thirds of the watershed, were built up from fine silt and clay sediments derived from the rivers discharging into the lake. The lake clay sediment soils have high fertility levels, are capable of producing a wide variety of agricultural crops, and form the main agricultural resource base of the area. The clay soils have poor internal and surface drainage and, when improperly managed, are subject to wind erosion.

This inner lake bottom is a flat featureless plain that has a gently northwestward slope to the Red River. The flat surface lacks natural watercourses and is presently broken only by road embankments and constructed channels which determine the watershed boundaries. A portion of this lake bottom contains small depressional areas (micro-relief). (See Figure 1.)

Figure 1. Micro-relief on Flat Land

The Red River that forms the western boundary of the watershed has cut a narrow entrenched channel about 35 feet into the lake bottom sediments. The major tributaries to the Red River, such as the Marsh River, have similarly entrenched themselves into the lake bottom. The channel banks along the Red River are considered as stable. This stability is because the soils composing the channel bottoms and banks consists of a lake clay that is erosion resistant. The vegetation along the channel banks consists mainly of trees and associated vegetation.

The channel bottom elevation of the Red River at the outlets of judicial ditches 52 and 54, lateral 1, is approximately 810 feet mean sea level. There is considerable fluctuation in the Red

River for various size flows. The 100-year-frequency flood elevation on the Red River is 859 feet mean sea level.

The main soil and water resource problem area is located in the lake plain area west of State Highway No. 9. There are approximately 26,000 acres that have floodwater removal problems. There are approximately 2.9 miles of active streambank erosion at the outlets of judicial ditches 52, 53, and 54, lateral 1.

There are 8,000 acres of cropland located throughout the watershed which have prolonged wetness conditions.

Nearly 90 percent of the soils are included in land capability classes II and III.

The extreme difference in elevation is about 175 feet with a mean sea level elevation of approximately 1,000 feet on the eastern watershed divide to 825 feet where the watershed empties into the Red River. However, most of this difference in elevation is in the eastern seven miles of the watershed and the escarpment along the entrenched flood plain of the Red and Marsh Rivers.

The area experiences wide seasonal variations in climate. The normal mean monthly temperature varies from 71° F. in July to 6° F. in January. The extreme temperatures recorded are a high of 111° F. and a low of -53° F.

The average date of the last frost in the spring is May 23 and the average date of the first frost in the fall is September 20, an average frost-free period of 121 days.

The normal annual precipitation is 21 inches with 14 inches occurring during the growing season from May through September. The normal annual snowfall is 36 inches which accounts for approximately 3.5 inches of the total precipitation.

The mineral resources are limited to small surface sand and gravel deposits located in the beach ridge area in the eastern one-third of the watershed. Ground water resources are generally adequate for farms and cities. The western two-thirds of the watershed experience the most difficulty in obtaining adequate water supplies since the lake clay deposits yield little water. Some flowing wells exist in the central and eastern portions of the watershed.

There is a 24-inch pipeline running nearly north and south through the watershed. This line is called the Midwest Pipeline and transports natural gas into the United States from Canada. The pipeline enters the watershed along the north side of section 36, T. 147 N., R 47 W., and leaves the watershed along the south side of section 30, T. 146 N., R. 46 W.

The land use in the watershed consists of 65,300 acres of cropland (90 percent), 2,200 acres of pastureland (3 percent), 355 acres of forest land (0.5 percent), and 4,645 acres of other land (6.5 percent).

There are 24,000 acres of cropland in the soil and water resource problem area. The remaining 1,900 acres of other land consists of roads, farmsteads, and channel areas.

The major drainageways in the watershed consist of man-made ditches that were constructed about 1915 in the western two-thirds of the watershed. These ditches were installed under the legal ditch procedure of Minnesota Statutes (Chapter 106) and are known as county ditches and/or judicial ditches. These legal ditch systems include judicial ditch 52 and six laterals, judicial ditch 53 and four laterals, judicial ditch 54 and county ditch 3, judicial ditch 54, lateral 1, and county ditch 28. There is a total of 72 miles of existing legal ditches in the watershed. (See map, Appendix A.)

Drainage adjacent to the legal ditches is accomplished primarily by man-made surface field ditches. The steeper sloping land in the upper one-third of the watershed is drained by small natural channels which outlet into the legal ditch systems or which drain into road ditches that are connected to these systems.

The flow is ephemeral in all drainageways except for the lower six miles of judicial ditch 52 where the flow is intermittent.

Water quality of the Red River is of the calcium-magnesium, carbonate-bicarbonate type with total dissolved solids in the range of 340 to 700 parts per million. The runoff waters have a sediment concentration in the range of 275 to nearly 2,000 parts per million.

The average annual runoff in the immediate region is 2.2 inches based on stream gage records for the Sandhill River at Climax. The annual runoff has varied from 0.7 to 6.8 inches since the gage was installed in 1943. During March, April, and May, 84 percent of the average annual runoff occurs.

There are 14,500 acres of type I wetlands and 1,000 acres of type II wetlands in the watershed. The majority (greater than 90%) of the types I and II wetlands are presently being used as cropland. There are small acreages of types I and II wetlands in pastureland, and other land.

The type III wetlands are located in the N½ sec. 18, T. 146 N., R. 47 W. These consist of 10 type III wetlands, each less than one acre in size. The land use has reverted to predominately native grasses and forbs.

Table A tabulates the size of the existing channel on the areas that would be modified by the plan.

Table A - Existing Channel Conditions

Channel	Station	Drainage Area (Sq. Mi.)	Bottom Width (Feet)	Depth[1/] (Feet)
Main No. 1--	19 to 28	73.3	(2)	(2)
	28 to 50	73.3	[3/]25	[3/]14.0
	50 to 99	72.8	[3/]20	[3/]14.0
	100 to 364	70.7	18	6.5
	364 to 682	46.7	12	3.5
	682 to 840	21.9	10	4.0
Main No. 1,- Branch 1	0 to 52	17.5	8	5.5
	52 to 105	16.6	8	4.0
Main No. 1,- Branch 2	0 to 214	17.0	8	1.0
Main No. 2--	0 to 7	4.6	[3/]20	[3/]12.0
	7 to 92	4.6	6	2.0
	92 to 355	3.1	6	3.0

1/ Effective depth to remove floodwater from adjacent land. All the side slopes of the channel are approximately 1½ to 1.
2/ No channel.
3/ Eroded channel.

Economic Data

The economy of the area is primarily based on the production and sale of agricultural products. About 80 percent of the cash farm income is from the sale of grain crops. The remaining cash income is from the sale of livestock and livestock products. The average gross income per farm in Norman County in 1969 for all farm products sold was $18,019.

There are approximately 220 farm operators which have all or parts of their farms within the watershed. The average size of a farm operation is about 600 acres, ranging from 80 to 2,000 acres. Farms located east of State Highway No. 9 are generally not as intensively farmed due to their sandy soils. The average value of the land in the flood-free portion west of Highway No. 9 is approximately $300 per acre. Land with flooding and prolonged wetness has an average value of $250 per acre. Land located east of Highway No. 9 has an average value of $200 per acre. All land in the watershed is in private ownership.

Principal crops and the average yield per acre for each of the major parts of the watershed are listed in the following table.

Table B - Principal Crops Grown and Average Yield

Crop	Unit	Flood-Free and Adequately Drained Area West of Hwy. 9	Soil and Water Resource Problem Area West of Highway 9	Cropland East of Highway 9
Wheat	bu	45	30.0	35
Barley	bu	55	35.0	45
Oats	bu	75	50.0	60
Sunflower	cwt	15	10.0	10
Hay	tons	4	2.5	3
Soybeans	bu	20	12.0	16
Corn	bu	60	40.0	50
Flax	bu	20	10.0	12
Sugar beets	tons	18	10.0	--------

The accessibility of farmers to the retail communities and market areas is served by U.S. Highway No. 75 along the western side of the watershed and State Highway No. 9 in the eastern portion. There are numerous county and township roads that serve the rural area.

The following statistics apply to social and economic conditions within Norman County (1970 population 10,008). They also apply reasonably well to the conditions within the watershed.

Yearly gross income of families and the percentage of the families in each income bracket are as follows:

Income	Percent
0-$4,000	29
$4,000- 8,000	40
8,000-12,000	18
12,000-25,000	12
25,000 and more	1

The average family income is $6,969.

The labor force represents 66 percent of all males 16 years old and over and 28 percent of all females 16 years old and over. Within each group, 94 percent are employed and the remaining 6 percent are unemployed. Most of the employment is in agriculture and agriculturally related businesses.

The following table shows the percentage of the total population in each age group and a comparison with the State of Minnesota for 1969.

Table C - 1969 Population Percentages by Age Groups for Norman County and State of Minnesota[1/]

Age Group	Norman County	State of Minnesota
0-14	27.0	30.8
15-24	12.0	17.0
25-34	8.9	11.7
35-44	9.9	10.6
45-54	11.8	10.5
55-64	12.4	8.7
65+	18.0	10.7
Total	100.0	100.0

1/ Minnesota Population, Trends, Estimates, Projections, Minnesota Department of Health, March 1972.

Norman County's population between the ages of 0 and 44 represents a lower percentage of the total population than is true for the State of Minnesota. Conversely, Norman County's population aged 45 years and over represents a larger percentage of the total population than for Minnesota.

Years of school completed of those 25 years old and older is less for Norman County population than for the State of Minnesota, as is shown in the following table.

Table D - 1970 Population Percentages by School Years Completed for Norman County and State of Minnesota[1/]

School Years Completed	Norman County	State of Minnesota
None	0.6	0.7
1- 4	2.9	1.7
5- 7	12.5	6.7
8	31.5	19.4
9-11	13.6	14.0
12	26.2	34.5
13-15	9.8	11.9
16+	2.9	11.1
Total	100.0	100.0

1/ U.S. Bureau of Census of Population, 1970 General, Social, and Economic Characteristics, Minnesota, PC(1)-C25.

About 85 family farms, including partnerships located in the watershed, experience economic difficulties due to flood damages.

Fish and Wildlife Resources

Approximately 90 percent of the watershed (65,300 acres) is cropland, with the majority of this being fall-plowed for spring seeding. There are no lakes or perennial streams to support any fisheries.

Year-round wildlife habitat, consisting mostly of perennial vegetation, is generally limited to the road and drainage ditches, type III wetlands, and the forested area. The area is not in the primary range of most game and fish species.

Sharptailed grouse, Northern greater prairie chicken, and pheasants are found in the watershed. Other species include: moose, deer, rabbits, ground squirrels, raccoons, and fox. Sandhill cranes are migrants which seasonally utilize the watershed. The watershed lies in the migratory range of several species listed in the "Threatened Wildlife of the United States", 1973 Edition, USDI, Fish and Wildlife Service. These include: Arctic peregrine falcon, American osprey, Eastern pigeon hawk, and whooping crane. The watershed is located on the extreme eastern edge of the native range of the Western burrowing owl and extreme western edge of the Eastern timber wolf.

Approximately 180 pheasants per hundred miles were counted on roadside surveys in 1963. In 1972, the count was 4 pheasants per hundred miles.

There are no major point sources of pollution in the watershed. The city of Lockhart (unincorporated) is presently using a septic tank system for their municipal waste. There are no farm feedlot operations or industries on the watershed.

Access availability to the existing resource is provided on private land by permission of the landowners.

The vegetation along the existing channel is comprised of a variety of grasses, forbs, and grasslike plants. On the lower or bottom parts of the channel and on the wetter soils, the dominant plants are prairie cordgrass and sedges. On the upper slopes, berms and spoil bank, the vegetation is a mixture of introduced species such as bromegrass, timothy, and quackgrass along with some of the native prairie species such as big bluestem, switchgrass, and Indiangrass.

Where recent cleanout or modification has disturbed the vegetative cover, the existing cover consists mainly of the introduced species such as bromegrass, timothy, and quackgrass. However, in those areas that have not been disturbed for a long period of time the native species are reestablishing themselves through natural succession.

There are a few remaining areas of native prairie where many of the native grasses and other prairie plants can still be found. A prairie plant community exists along some railroad rights-of-way, road ditches, and fence lines. In its natural state, this plant community is dominated by big bluestem, prairie cordgrass, Indiangrass, and switchgrass. Less prominent varieties of grasses include slender wheatgrass, tall dropseed, Canada wildrye, redtop, and bluegrass. Other plants including prairie-clovers, lead plant, tall gayfeather, and goldenrod are common.

The forested area is located mainly in the entrenched flood plain of the Red and Marsh Rivers. The primary species consists of elm, oak, ash, cottonwood, and basswood. There are scattered areas of aspen in the upper reaches of the watershed.

Recreational Resources

Outdoor recreational facilities in surrounding areas are limited to municipal parks and playgrounds. There are no developed recreational areas within the watershed. Recreational activity in regard to fish and wildlife in the watershed is limited. The watershed has limited water-based recreation due to the lack of lakes and streams.

The people of Norman County recognized the need for developing outdoor recreation facilities and have developed a "County Parks and Recreation Facilities Plan". This plan includes the development of a wayside park located along State Highway No. 9 in section 5 of Lockhart Township, 3½ miles north of the city of Lockhart. This facility will require tree planting, a minimum of three picnic tables, potable water supply, and restroom facilities.

A county park is proposed northwest of the city of Shelly at the confluence of the Red and Marsh Rivers. This site of 50 acres will provide for camping, picnicking, and boating.

A proposed Twin Valley Lake Project on the Wild Rice River is located 20 miles southeast of the watershed just outside the city of Twin Valley. The reservoir will have a recreation pool area of 530 acres. The proposed recreational facilities to be developed near the pool will accommodate 24,900 recreation visits annually within 3 years after the reservoir is completed. Additional recreational facilities may be added as necessary until the year 2020 when the reservoir would accommodate an expected 59,000 recreation visits. Facilities will be provided for boating, fishing, swimming, picnicking, and camping. The proposed recreation facilities will provide a part of the needed water-based recreation.

Archeological, Historical, and Unique Scenic Resources

There is a mound (site No. 21 PL5) located in the NE¼ sec. 33, T. 147 N., R. 45 W. The mound (site No. 21 PL5) will not be affected by the proposed project.

The locally significant Lockhart farm is located near the city of Lockhart, Minnesota.

The city of Shelly was named in honor of John Shelly who settled along the Red River in 1870.

In accordance with the National Historic Preservation Act of 1966 (Public Law 89-665), the National Register of Historic Places was consulted and no places were listed within the watershed.

Soil, Water, and Plant Management Status

The present land use, primarily agricultural uses, is expected to continue. The general trend is toward larger farming units and a cash-grain enterprise.

The cooperators of the East Agassiz and West Polk Soil and Water Conservation Districts have followed an active program of planning and applying needed land treatment measures. There are 97 district cooperators which have all or part of their farms in the watershed. This represents 50 percent of the watershed acreage. Soil and water conservation plans have been developed on 85 farms covering about 40 percent of the watershed.

In 1958, the Soil Conservation Service, through the East Agassiz Soil and Water Conservation District, provided plans and specification for a grade stabilization structure at the outlet of judicial ditch 54. This structure was constructed with financial assistance from an Agricultural Stabilization Conservation Service pooling agreement with landowners.

The status of land treatment is summarized as follows:

Land Use	Adequately Treated (Acres)	Inadequately Treated (Acres)
Cropland	19,400	45,900
Pastureland	600	1,600
Forest land	180	175
Other land (Managed for Wildlife)	500	500

The practices applied on these lands include conservation cropping systems, crop residue management, field windbreaks, minimum tillage, drainage field ditches, pasture and hayland

management, and wildlife upland habitat management. The remaining 3,645 acres of other land consist of farmsteads, channels, roads, the city of Shelly, and the city of Lockhart.

Adequate forest fire protection is provided by the local fire departments and the Minnesota Department of Natural Resources, Division of Lands and Forestry, in cooperation with the U.S. Forest Service through the Clarke McNary Cooperative Forest Fire Control Program. Other current federal-state cooperative forestry programs include: Cooperative Forest Management, Cooperative Forestation, and Cooperative Forest Pest Management.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land Treatment

Approximately 70 percent (45,900 acres) of the cropland is presently inadequately treated. Wind erosion is a hazard throughout most of the entire watershed especially in late fall and early spring. The lighter-textured soils in the eastern part of the watershed are especially susceptible to wind erosion. Lack of vegetative cover and roughness of the land surface is responsible for the wind erosion hazard in the lake plain area when flooding or wetness prevent normal crop production. The average annual soil loss from wind and water erosion is approximately 1.1 tons per acre.

Most of the damage occurs from the deposition of sediment in drainage field ditches and road ditches which are a part of the drainage network. This sediment and plant nutrients (N,P&K) are the major source of pollutants in the runoff water. Damage to a lesser degree also occurs in the form of damage to crops and air pollution.

Many of the outlets of drainage field ditches are eroding and contributing to the sediment deposition in ditch mains and laterals.

The efficient practice of rotating intensively grown crops, such as sugar beets and small grains, is hindered by the flooding conditions. The land users are forced to fallow more frequently than on the flood-free fields. The fallow conditions contribute to a greater wind erosion hazard.

Approximately 70 acres of forest land are inadequately stocked or are in poor condition. This is due to dead, diseased, or over mature trees.

Floodwater Damages

Frequent flooding of cropland in the major problem area (26,000 acres) is located in the western two-thirds of the

watershed adjacent to the judicial ditch systems. The existing channels and bridges have limited capacities resulting in the floodwaters covering a large area due to the lake plain surface. (See Figure 2.) Runoff from the steeper sloping land in the upper one-third of the watershed contributes to the flooding on the lake plain.

Figure 2. Typical Flooding on Lake Plain.

Damage from runoff (snowmelt and rain) often occurs during the same year. Floods from snowmelt runoff cause a delay in seeding crops. Any delay beyond normal seeding date of crops results in a reduction of yields.

Floods from summer storms cause damage to growing crops. Sugar beets are especially sensitive to prolonged flooding. Other crops are also damaged from short periods of inundation, resulting in lower yields and poorer quality. Floods during the harvest season can result in total crop losses.

Other agricultural damage associated with flooding occurs in the flooded area. These damages include the loss of stored grain, expenses involved in moving livestock and hauling feed to them, deterioration of machinery and buildings subject to floodwaters, costs for debris removal, and costs involved with pumping water from basements. Another common damage is the infestation of weed seeds by the floodwaters. Additional expenses are incurred by the land users to control the growth of weeds.

Indirect damages resulting from floodwaters include loss of production time, extra travel, and delays in conducting business. A flood causes an interruption in the farming activities resulting in an inefficient operation. Flooded roads require the traffic to detour and travel greater distances. Business transactions are often delayed and interrupted resulting in a less efficient operation.

Judicial Ditches 52 and 54, Lateral 1

The area flooded by a 100-year frequency flood is 18,400 acres within the watershed. The majority of the flooded area is on the south side of judicial ditch 52 from State Highway No. 9 west to the Red River. There are several areas where entire sections of land are flooded. In addition, there are 1,600 acres of land flooded adjacent to judicial ditch 52 on the outside of the watershed boundaries. The land use, on the 20,000 acres subject to flooding, includes 18,700 acres of cropland and 1,300 acres of other land. The other land use consists of roads, farmsteads, and channel areas.

The area flooded by the runoff of a 5-year frequency flood is 18,200 acres.

Flooding on the lake plain area occurs on an average of once every year because of the limited capacities of the channels and bridges. There are 12 bridges and 8,400 feet of road that receive damages from floodwaters on these judicial ditch systems.

There are 85 landowners located in the problem area.

Judicial Ditch 53

The area flooded by a 100-year frequency flood is 6,000 acres. The flooded area is adjacent to the ditch main starting at State Highway No. 9 and continuing west to the Marsh River. The land use on the 6,000 acres subject to flooding includes 5,400 acres of cropland, and 600 acres of other land. The other land use consists of roads, farmsteads, and channel areas.

The area flooded by the runoff of a 5-year frequency flood is 5,000 acres.

Flooding on the lake plain area occurs on an average of once every other year. There are 12 bridges that receive damages from floodwaters on this judicial ditch system.

There are 15 landowners located in the problem area.

Recent Flood

The 1969 snowmelt flood was one of the larger floods to occur in the watershed. Peak runoff from the melting snow occurred around April 9 in the eastern part of the watershed. The coarse-textured soils warmed up quicker and encouraged thawing of the snow and ice several days earlier than that located on the flatter, finer textured soils in the western two-thirds of the watershed. As a result, meltwaters from the more sloping part of the watershed approached the flatter portion and quickly spilled out of the main channels and onto the cropland.

Considerable snow and ice still remained within the channel in the flatter portion of the watershed, further reducing the present limited channel capacity. In some areas, nearby trees shaded the channel area delaying the melting process. Channels located near the roads were packed with snow and ice from the snowplowing operations during the winter. These channels were also slow to thaw out. In many cases, road culverts and bridges were filled with snow and ice, plugging the channel.

Runoff water continued to flood on the cropland until either enough head was built up clearing the plugged road culvert or bridge or until the water flooded the road. Usually the complete section was flooded by this time. The process repeated itself on each section as the floodwaters moved downstream. Peak flood conditions occurred on April 11 in the central part of the watershed and on April 14 in the western part of the watershed. The Red River, at the outlet of the watershed, peaked on April 20. Total area inundated within the lake plain of judicial ditches 52 and 54, lateral 1, approximated 14,275 acres. There were 3,400 acres flooded on the judicial ditch 53 system. Farm operations were delayed up to 2 weeks as a result of the flood conditions in the flatter areas of the watershed west of Highway No. 9. Yield reduction ranged up to 20 percent as a result of the delayed seeding.

The floodwaters have very little effect, if any, on the health and lives of the people in the watershed.

Erosion Damage

Wind and water erosion is a problem in the watershed. This erosion has only a limited effect on the soil for sustained cropland production.

Wind Erosion

The potential exists for sufficient wind to occur which could result in excessive soil loss. A single occurrence on a small area of land may have an insignificant effect on the land damage. However, these occurrences may cause damage to the drainage

networks and other works of improvement. It is common to observe a soil loss from wind in excess of 20 tons per acre from a single field during a particularly severe occurrence. Such an event may only occur once in 20 years on a particular field. A soil loss of only one ton per acre, if adjacent to a drainageway, may totally block that section of the system. (See Figure 3.)

Figure 3. Wind Erosion

Water Erosion

The water erosion problems occur where the field ditches empty into drainage mains and laterals. The erosion is not severe but the resulting sediment deposition in the mains and laterals does cause maintenance problems.

The annual gross erosion rate from wind and water is estimated at 1.1 tons per acre, or 80,000 tons for the watershed. The airborne dust portion of the erosion has not been accounted for in the erosion rates.

Streambank Erosion

The county and judicial ditch systems, constructed mainly before World War I, cut diagonally across the natural drainage pattern. As a result, the constructed ditches were outletted directly over the steep bank of the Red River. Attempts were made to control the large drop (approximately 30 feet) from the lake plain surface to the Red River flood plain with concrete and steel sheet pile structures. These structures were installed on judicial ditches 52, 53, and 54, lateral 1.

These structures have washed out and the channels are cutting headward, deepening and widening from their junctions, with the flood plain of the Red River and, in the case of judicial ditch 53, the Marsh River. A total of 2.9 miles (15,300 feet) of channels are undergoing active erosion. Massive bank sloughing occurs periodically on both banks along the actively eroding channels. (See Figure 4.)

Figure 4. Streambank Erosion

Judicial ditch 52 has active erosion on the lower 11,000 feet of channel. Two sheet pile drop structures have failed and the streambank erosion is continuing. There are approximately 14,000 tons of soil being eroded away annually from the channel bank and bottom. Land voiding amounts to approximately 0.7 acre per year. The streambank erosion has destroyed one township bridge, endangered a cemetery, and is threatening to undermine bridges on the Burlington Northern Railroad and U.S. Highway No. 75.

Judicial ditch 54, lateral 1, has active erosion on the lower 800 feet of the channel. A reinforced concrete drop structure at the outlet has failed and the streambank erosion is continuing uncontrolled. There are approximately 1,000 tons of soil being eroded away annually from the channel banks and bottom. Land voiding amounts to approximately 0.05 acre per year.

Damages to bridges, culverts, roads, side inlets, telephone and electrical lines, and land voiding are a result of the streambank erosion.

Sediment Damage

Road ditches and channels are undergoing sedimentation due to wind and water erosion from adjacent fields and field outlet ditches. (See Figure 5.) The damage is reflected in road ditch maintenance and channel cleanout costs which are absorbed by the county taxpayers for the roads and by farmers for the legal ditch systems. The streambank erosion at the outlet of the main ditch systems is contributing to the total sediment delivered to the Red River.

Figure 5. Sediment Deposition in Road Ditch

The sediment yield from wind and water erosion is estimated at 18,000 tons per year. The sediment yield from streambank erosion is estimated at 19,500 tons per year. The annual sediment yield to the Red River from the watershed amounts to 37,500 tons, or an annual yield of 0.52 ton per acre. On this basis, the average annual sediment concentration in the annual runoff waters amount to 2,050 parts per million from Norman Polk Watershed.

Drainage Problems

Small depressional areas (8,000 acres) with a prolonged wetness condition from precipitation and storm runoff are located throughout the watershed. They are more numerous in the micro-relief topography in Good Hope Township and the eastern portion of Shelly Township.

The irregular pattern of wet and dry areas, in the micro-relief topography, make it impractical to operate farm machinery until a field has reached proper soil moisture conditions. Thus, damages not only occur in the depressional areas but also in the adjacent areas. Damages sustained from prolonged wetness are mainly reduced crop yield, lower quality crops, and higher production costs. During wet years, monetary losses are substantial due to the inability of timely land preparation, planting, cultivation, and harvesting.

There are 4,000 acres of small depressional areas with a prolonged wetness condition located in the major problem area of judicial ditches 52 and 54, lateral 1, system. This area has inadequate outlets for the depressional areas.

There are 1,200 acres of depressional areas with prolonged wetness on judicial ditch 53 system problem area. The remaining 2,800 acres of depressional areas are located in scattered areas through the remainder of the watershed.

Plant and Animal Problems

Past land use, which was primarily native prairie and wetlands, and some forest land, has changed primarily to cropland. This trend has reduced the quantity and quality of habitat for wildlife.

Economic and Social Problems

The watershed is designated as an economically depressed area with lower incomes, higher unemployment rates, less school years completed, and a higher percentage of older people characterizing the area.

The median earnings in 1969 for all males 16 years old and over in the labor force was $4,870. For all females 16 years old and older in the labor force, the median earnings was $2,042. This was considerably less than the median for Minnesota which was $7,730 and $3,175 respectively. Twenty-nine percent of the rural farm families earned less than $4,000 gross income. A similar percentage also existed for the incomes of rural non-farm families.

Full time farm operators that sold farm products valued at less than $5,000 accounted for 26 percent of the total farm operations. Twelve percent of the farm operators sold farm products valued at less than $2,500.

Six percent of the rural labor force was unemployed in 1970.

Only eleven percent of all farm operators used one and one-half man-years or more of hired labor.

Although the above statistics apply to Norman County, they describe reasonably well the actual conditions in the watershed. A need exists for rural community development. More employment opportunities are needed in order to increase incomes and keep the younger members of the population within the community.

Hazards exist in operating farm machinery along the vertical side slopes of the eroded portions of judicial ditch 52, judicial ditch 53, and judicial ditch 54, lateral 1.

PROJECTS OF OTHER AGENCIES

Judicial ditch 54 and county ditch 3 along with county ditch 28, are being improved by local interests under State Statutes, Chapter 106. The hearings are being conducted by the Norman County Board of Commissioners. All costs of this improvement will be paid by assessment to the beneficiaries of the project.

PROJECT FORMULATION

An application for assistance under Public Law 83-566 was submitted to the Minnesota State Soil Conservation Committee for the Governor of Minnesota on August 16, 1963. The State Committee approved the application on December 12, 1963, and placed it on priority for planning on July 27, 1964. The preliminary investigation report was presented at a public meeting in Beltrami, Minnesota, on May 10, 1966. The Sponsors decided to proceed with the development of a Public Law 83-566 plan.

During the development of the plan, a tri-agency biology inventory was made of the biological resources of the watershed. This report made recommendations to consider in the development of a plan.

A recommendation stated that the natural grassland in the eastern half of section 32 and western half of section 33, T. 147 N., R. 45 W. be preserved to save the habitat of the prairie grouse. This was discussed with the Sponsors and they recommended that some agency or organization be asked to purchase the area. The Bureau of Sports Fisheries and Wildlife and the Minnesota Department of Natural Resources were contacted about possible purchase. The Bureau of Sports Fisheries and Wildlife stated that this was not eligible for purchase with the funds they administer. The Department of Natural Resources investigated the proposal and recommended against any purchase.

Another recommendation of the biology team was the purchase of 320 acres of land in the north half of section 18, T. 146 N., R. 47 W. The Nature Conservancy was contacted about possible purchase. To date, there has been no indication of interest from them.

The Minnesota Historical Society was contacted for any known archeological and historical information they had on record which might be affected. The information was utilized in the development of the plan.

The Minnesota Department of Natural Resources made a recommendation that diked floodways be constructed adjacent to the existing ditches in lieu of the proposed plan. The dikes were to be in grass, trees, and shrubs for windbreaks and wildlife habitat. After several meetings between the Department, Sponsors, and the Service, it was agreed the plan, as originally proposed, was satisfactory.

Several public meetings were held with the Sponsors and concerned land users to develop a plan satisfactory to them. The Sponsors called a public meeting on March 15, 1973, to review the proposed work plan with the public agencies and organizations. As a result of the review and favorable comments received at this meeting, the Sponsors decided to take the necessary steps to implement the plan.

The watershed is located within the Red River Subregion of the Souris-Red-Rainy Region, under the jurisdiction of the Upper Mississippi River Basin Commission, as designated by the Water Resource Council. The drainage area of the Red River Subregion is approximately 40,000 square miles. There is one pilot watershed that has been completed in North Dakota.

There are 42 Public Law 83-566 active applications for assistance within the Red River Subregion. These applications cover an area of 10,202 square miles or 25 percent of the region.

There are 27 projects that have been authorized to develop plans on in the subregion. The area covers 6,452 square miles or 16 percent of the area.

Of those authorized for planning, 18 have been approved for construction. The area covers 4,429 square miles or 11 percent of the area.

There are nine projects in which the construction has been completed. This involves 2,394 square miles or 6 percent of the subregion.

The projects installed under Public Law 83-566 consist of conservation land treatment, floodwater-retarding reservoirs, multipurpose structures, diversion, dams, floodways, channel diversions, and channel improvement.

Objectives

The Sponsors and the Soil Conservation Service agreed upon the following measures and degree of protection that should be included in the plan.

1. Intensify the installation of soil and water conservation practices so that 70 percent of the watershed will be adequately treated at the end of the project installation period.

2. An intensive land treatment program to protect the improved channels from sedimentation caused by wind erosion. Permanent type land treatment measures, in the form of field windbreaks, will be installed on at least 50 percent of the land, 1 mile north and west and ½ mile south and east of the improved channel prior to the construction of the structural measures.

3. Provide 5-year frequency flood-free protection of the lake plain area of the watershed by enlarging and deepening the present channels and replacing inadequate bridges and culverts.

4. Install grade stabilization structures at the outlets of the channel improvement into the Red River of the North and other reaches where the channel is not stable, to prevent channel erosion.

Environmental Considerations

To reduce the adverse environmental effects, two decisions were reached by the Sponsors.

1. Floodwater retarding reservoirs will be the first structural alternative considered in project formulation.

2. Use existing channel locations to the fullest extent possible. This will minimize the adverse impacts associated with farming operations and the road and bridge network.

Alternatives

Alternatives considered in the development of the plan are as follows:

Land Treatment

The application of all possible conservation practices is an alternative. The cost of land treatment measures is estimated at $560,000. Such measures as conservation cropping systems, minimum tillage, crop residue management, field windbreaks, tree planting, pasture and hay land management, wildlife and upland habitat management, and related measures would be applied on the watershed.

The impacts of this alternative are:

1. Reduce floodwater damages by 3 percent. This represents about $4,700 of the total floodwater damages.

2. Increase land adequately treated from 20,680 to 46,500 acres.

3. Increase wildlife habitat.

4. Reduce annual wind and water erosion from 1.1 to 0.8 ton per acre.

5. Improve environmental aesthetics on adequately treated areas.

6. Reduce sedimentation from 37,500 to 33,300 tons per year.

Single-Purpose Flood-Prevention Structure and Channel Work

Installation of a single purpose floodwater-retarding structure and channel work is an alternative. The structure would be located in section 34, T. 147 N., R. 46 W. The channel work would be similar to that in the plan. The retarding structure and channel work would cost approximately $1,720,000.

This combination of structural measures would provide 5-year frequency flood-free protection and drainage of surface waters.

The impacts, in relation to judicial ditches 52 and 54, lateral 1, systems of this alternative are:

1. Relocate one farming operation.

2. Reduce acres flooded from a 5-year frequency event from 18,200 to 0 acres.

3. Reduce road and bridge damage by 56 percent.

4. Reduce land voiding from 0.75 to 0 acre per year.

5. Improve maintenance program on channels.

6. Reduce contributing drainage area on judicial ditch 53 system.

7. Reduce placement of snow in the channel from the snow removal operations on the roads.

8. Reduce operating hazards along channels.

9. Reduce, temporarily, the soil fertility on 55 acres of spoil bank area.

10. Increase sediment during construction.

11. Increase peak discharge into Red River.

12. Reduce or eliminate traffic on six township roads by removal of bridges and culverts.

13. Removal of 5 acres of forest land.

14. Removal of 670 acres of cropland from agricultural production.

15. Reduce annual flood and streambank erosion damage by about 73 percent.

16. Reduce sedimentation outflow from 37,500 to 22,500 tons per year.

17. Improve wildlife habitat.

Diked Floodway

The establishment of a diked floodway is an alternative. This would involve the construction of dikes along the existing channels, enlargement of bridges, installation of pumping systems, and the construction of collection channels and collection basins. The diked area would be similar to the channel work in the plan. This plan would require the use of pumping systems to remove the surface waters from the fields. The diked floodway system would cost approximately $2,700,000. The annual operation and maintenance cost is estimated at $32,000.

This diked floodway system would provide 5-vear frequency flood-free protection and drainage of surface water.

The impacts of this alternative are:

1. Reduce acres flooded from a 5-year frequency event from 18,200 to 0 acres.

2. Reduce road and bridge damage by 56 percent.

3. Reduce annual flood and streambank erosion damage by about 73 percent.

4. Reduce land voiding from 0.75 to 0 acre per year.

5. Improve early spring runoff from fields with reduced snow deposition in channels.

6. Reduce operating hazards along channels.

7. Increase of sediment during construction.

8. Reduce or eliminate traffic on six township roads by removal of bridges and culverts.

9. Removal of 590 acres of cropland from agricultural production.

10. Improve wildlife habitat.

The selected plan includes installation of land treatment and structural measures that will: (1) Improve soil and water conservation, (2) Reduce floodwater and streambank erosion damages, (3) Improve drainage outlets, within an acceptable amount of needed capital and land resources.

The channel work and grade stabilization on judicial ditches 52 and 54, lateral 1, is in line with the main objective of the Sponsors and has a favorable benefit cost analysis.

Similar channel work and grade stabilization was investigated on judicial ditch 53. Preliminary studies showed that benefits gained from a reconstruction of channel would not justify the costs it incurred. As a result, the people have initiated a maintenance program.

The plan allows for the proper land use in the interest of soil and water conservation and improves the quality of the environment in the natural resources base.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The soil and water conservation practices will be installed throughout the watershed during the 6-year installation period. Additional land that will be adequately treated includes 26,750 acres of cropland, 1,500 acres of pastureland, 70 acres of forest land, and 450 acres of other land managed for wildlife.

The application of soil and water conservation practices will continue beyond the project installation period.

Land users will also be encouraged through their local soil and water conservation districts to use proper fertilizer and pesticide management.

Some of the conservation practices planned to be applied include:

Land Use	Conservation Practice	Description of Practice
Cropland	Conservation Cropping System	Growing crops in combination with needed cultural and management measures to reduce erosion.
	Crop Residue Management	Using plant residues to protect cultivated fields during critical erosion periods.
	Minimum Tillage	Limiting the number of tillage operations to those that are properly timed and essential to produce a crop and prevent soil damage.
	Field Windbreaks	One or more rows of trees or shrubs established within or adjacent to a field to protect the soil or the growing crop from wind damage.
	Drainage Field Ditches	A graded ditch for collecting and removing excess water within a field.
Forest Land	Tree Planting	Planting tree seedlings or cuttings.
Pastureland	Pasture and Hayland Management	Proper stocking, timely grazing or harvesting, fertilizing to maintain or improve the quality and quantity of forage, to protect the soil and reduce water loss.

Other	Wildlife Upland Habitat Management	Retaining, creating, or managing wildlife habitat on the upland.
	Ponds	A water impoundment made by constructing a dam or embankment or by excavating a pit or dugout for pasture and wildlife management.

A combination of two or more practices may be needed to adequately treat the land.

A system of field windbreaks will be installed prior to construction. Windbreaks, at least 110 miles in length (440 acres), will be established adjacent to a minimum of 50 percent of the cultivated fields that are 1 mile north and west of the channels and ½ mile south and east of the channels. The windbreaks will be at least 10 rods (165 feet) back from both sides of the channel. Additional conservation practices installed and conservation plans will be required on at least 50 percent of the above described area.

Proper management and appropriate forest land treatment measures will be applied to 70 acres. This will primarily involve the establishment and improvement of tree and shrub cover. Guidance to land users will be provided through the preparation of forest management plans. Technical assistance will be provided by the Minnesota Department of Natural Resources in cooperation with the U.S. Forest Service.

The Sponsoring Local Organization estimates that an additional 60 land users will become cooperators with the Soil and Water Conservation Districts. An additional 50 land users are expected to develop conservation plans during the project installation period. Technical assistance will be provided by the Service.

Soil surveys will be prepared on an additional 8,500 acres of land. Technical assistance will be provided by the Service.

Structural Measures

The structural measures planned include 28 miles of channel work, six major grade stabilization structures within channels, and numerous grade stabilization structures on side inlets. Channel work includes enlargement of 22.5 miles of previously constructed channels, enlargement of 3.9 miles of existing field ditches, 0.3 mile of new channel work and 1.5 miles of channel stabilization. This channel work is on judicial ditches 52 and 54,

lateral 1, systems. There is no planned action on judicial ditches 53 and 54 and county ditch 28. (See Appendix B.)

All channels are designed to carry the 5-year frequency flood within the channel banks. Floods of greater magnitude will continue to flow overland, although they will not flood as large an area or for as long a duration.

The channels will be constructed mostly in massive lake clays but will also pass through fine silty sands and sandy beach ridge deposits.

All channels will be constructed with 4 to 1 side slopes, 15 foot berms, and shaped spoil banks outside the berms.

See figures 6 and 7 for examples of typical cross sections of the channels that are planned.

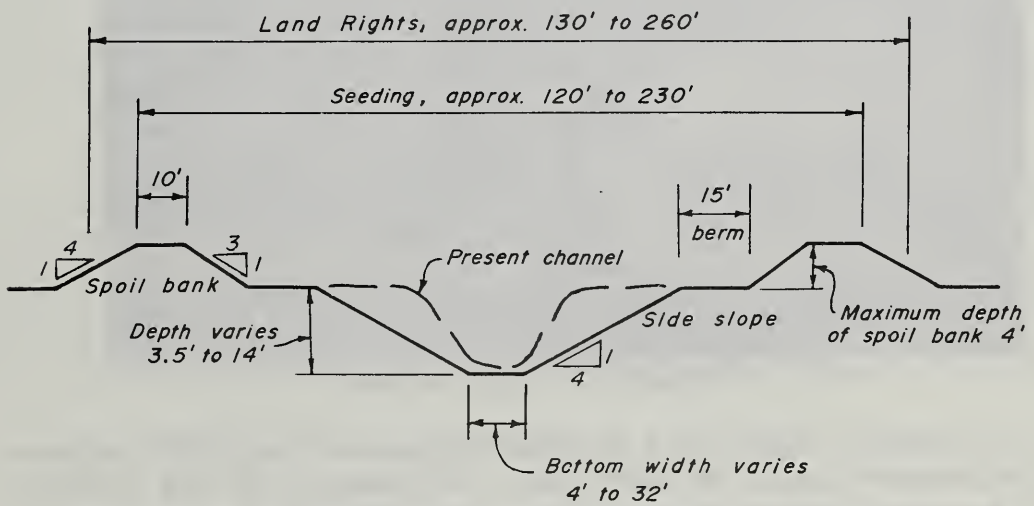

Figure 6. Typical Cross Section of Planned Channel Without Adjacent Road.

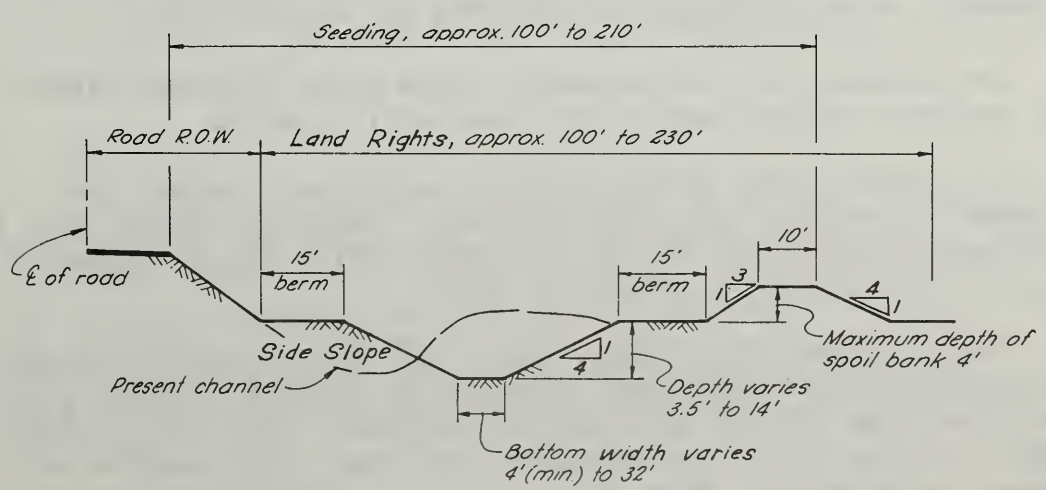

Figure 7. Typical Cross Section of Planned Channel with Adjacent Road.

Grade stabilization structures consisting of pipe inlets (approximately four to six per mile), gated where necessary, will be used to allow surface water to flow into the enlarged channel. Existing laterals which enter a deepened main channel will be excavated near their outlets until a stable grade is provided, or a grade stabilization structure will be installed. (See Figure 8.)

Figure 8. Pipe Inlets

The channel work will involve reconstruction of 13 bridges and culverts, repair of one bridge, replacement of one bridge with a combination bridge and grade stabilization structure, replacement of one road culvert by a combination culvert and grade stabilization structure, and removal of 10 bridges and culverts. Eleven bridges and culverts are satisfactory.

The channel will be excavated below grade at given points for sediment control during the construction period.

The channel side slopes will be fertilized, seeded, and mulched for erosion control protection. These operations will be performed concurrently during the construction of the channel with an interval not to exceed 15 days.

The unshaped spoil banks, berms, and other disturbed areas, not scheduled for shaping for a period of 30 days or more, will be protected from erosion by broadcast seeding. This will provide temporary cover until the earliest date that final grading and shaping is possible. When these areas are constructed according to plans and specifications, they will be fertilized, seeded,

and mulched within 15 days. The construction of all structural measures in this plan will comply with federal, state, and local regulations concerning air and water pollution.

The establishment period for the structural measures shall extend for 3 years from the date the structural measures are accepted from the contractor as being completed. This time allows for any latent defects or design deficiencies to become apparent. The establishment period for vegetative work associated with a structural measure will terminate when any of the following conditions are met: (1) Adequate vegetative cover is obtained, (2) Two growing seasons have elapsed after the initial installation of vegetative work, and (3) The establishment period for the associated structural measures has terminated.

During the establishment period for the vegetative measures, the Service may approve Public Law 83-566 cost-sharing for any additional work required to obtain an adequate vegetative cover. Approval of the Service Administrator is required for Public Law 83-566 cost-sharing for other repair or additional work on the completed structural measures.

Provisions of Public Law 86-523 relating to the preservation of historical and archeological data will be followed. No known archeological or historical sites will be affected by the project. Should any historical or archeological material be uncovered during construction, the Midwest National Park System Archeological Center will be notified. An appropriate agreement will be made between the Center and the Service on the steps to be taken.

The channel work is designated as: Main No. 1; Main No. 1, Branch 1; Main No. 1, Branch 2; and Main No. 2. (See Appendix B.)

The channel work with associated grade stabilization structures are discussed in more detail in the following paragraphs. Table E, pages 38 and 39, summarizes the channel sizes, drainage area, land use, land rights, and types of channel work planned for various reaches.

Main No. 1

Approximately 82,100 feet (stations 19 to 840) of channel works will be installed, commencing at the Red River along the north side section 1, T. 146 N., R. 49 W., and continuing due east to the northeast corner section 4, T. 146 N., R. 46 W. (See Appendix B.) The channel will convey the runoff from a 73-square mile drainage area. The shaped spoil bank on the north side of the channel will be one foot or more higher than on the south side.

The lower 2,800 feet of the existing channel flowing in a northwesterly direction will be replaced with 900 feet of new channel. The new channel will flow straight west to the Red River. Between stations 19 and 22 of the new channel, a grade stabilization structure S-1 (a chute spillway, along with 100 feet of structure outlet channel, will be constructed to drop the water 35 feet to the normal water level of the Red River. (See Figure 9.) This will require the clearing of 2 acres of forest land and the removal of 1 acre of cropland.

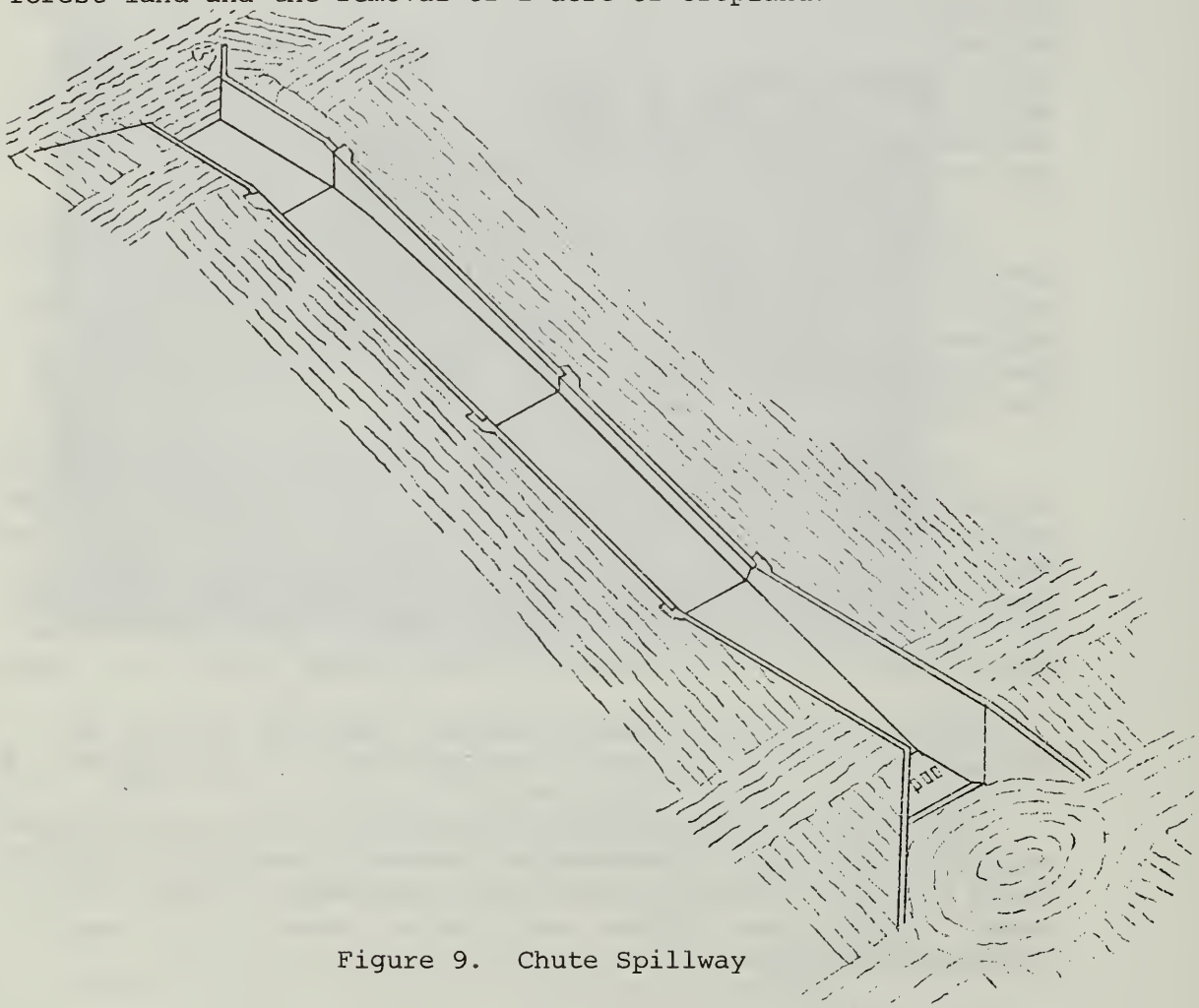

Figure 9. Chute Spillway

The next 600 feet (station 22 to 28) of new channel will be constructed in lake clay material. The channel work will require the removal of 3 acres of cropland.

The lower 2,800 feet of judicial ditch 52, the portion which flows in a northwesterly direction, will be abandoned and separated from the planned main No. 1. The main No. 1 channel, in the vicinity of the abandoned channel, will be diked to prevent flow from entering the abandoned channel. The dike on the north side of the channel will be one foot higher than on the south side. There is no planned action for the abandoned channel.

The next 7,100 feet (stations 28 to 99) of channel work will consist of filling and shaping the existing eroded channel to provide a new stable channel. The fill materials will be obtained from the excavation of the new channel (stations 22 to 28) and grade stabilization structure S-1. Suitable clay material that will withstand the planned velocity of 4.5 feet per second will be used. The channel work will require the removal of 11 acres of cropland in addition to the 18 acres already in the channel areas.

At station 50, grade stabilization structure S-1A (box inlet drop spillway) will be installed to drop the water 8 feet to the grade of the reconstructed channel. (See Figure 10.) A bridge will be installed across the box inlet drop spillway to provide for a crossing for the north-south township road.

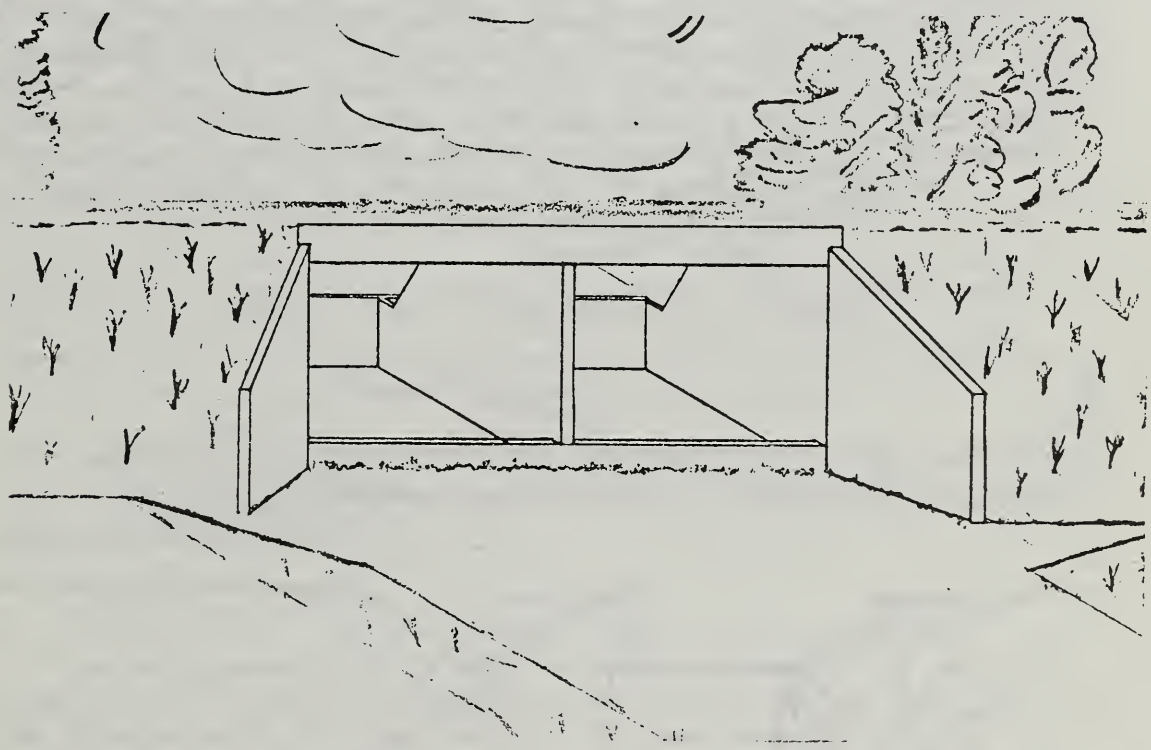

Figure 10. Box Inlet Drop Spillway

The channel from about 20 feet below the Burlington Northern Railroad (station 99) to U.S. Highway No. 75 (station 100) will be riprapped.

At station 100, grade stabilization structure S-1B, will have a weir constructed on the upstream apron or a straight drop structure installed immediately upstream of the present twin box culvert at U.S. Highway No. 75. This will drop the water 2 feet. (See Figure 6.) The grade stabilization structure will be designed to have minimal effect on the twin box culvert's capacity.

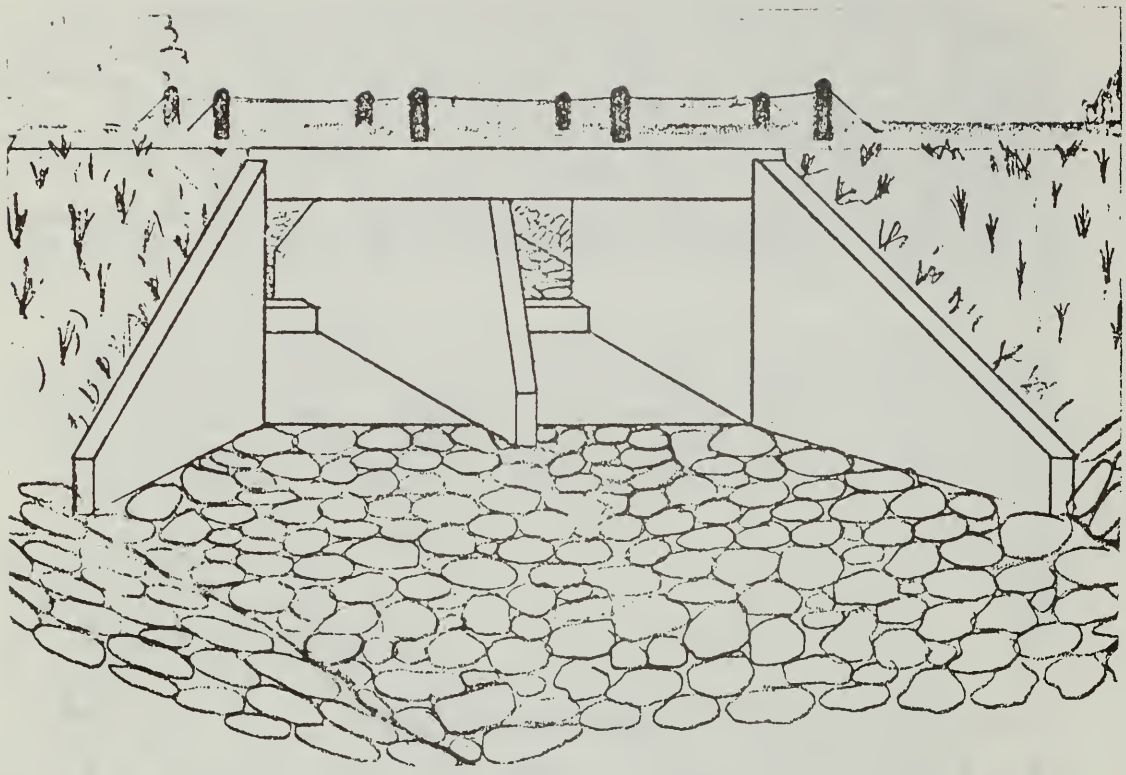

Figure 11. Raised Weir to Box Culvert

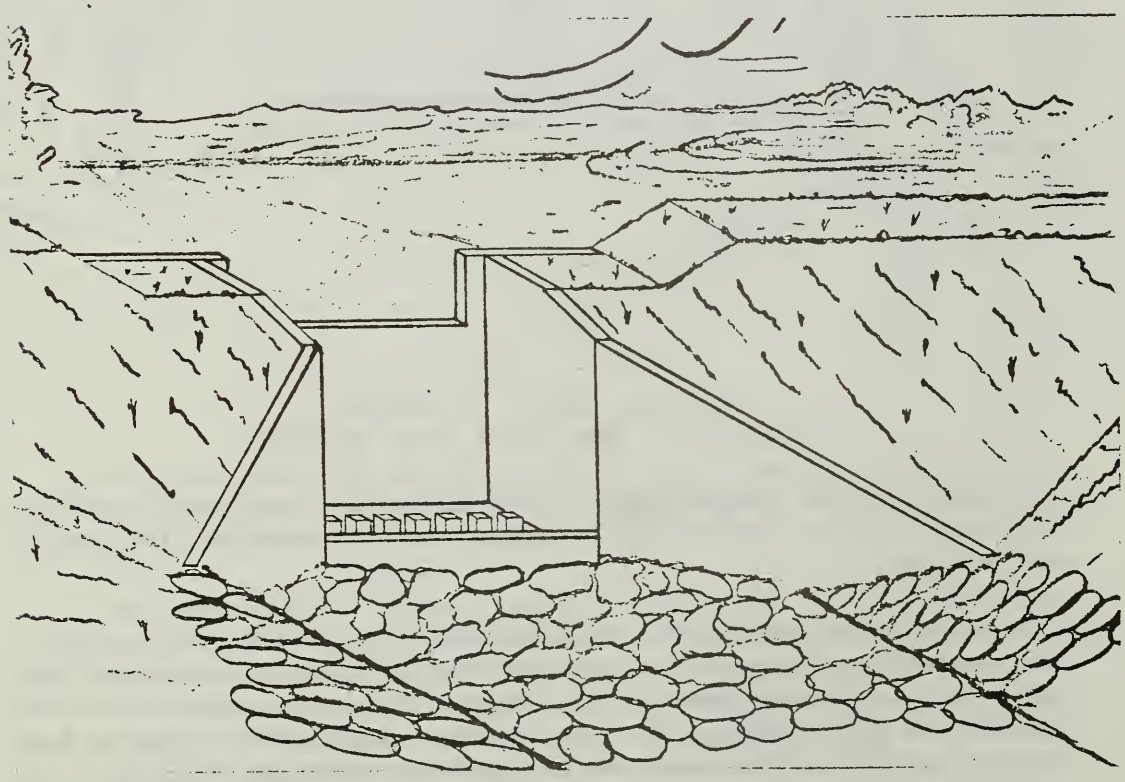

Figure 12. Straight Drop Spillway

Riprap will be placed at the foot of the retaining wall that protects the cemetery immediately upstream of U.S. Highway No. 75.

Continuing upstream a distance of 74,000 feet (stations 100 to 840), the channel work will widen and deepen the previously man-made channel. The channel work will require the removal of 125 acres of cropland in addition to the 137 acres already in the channel area.

At station 820, grade stabilization structure S-1C (straight drop spillway) will be installed to drop the water 6 feet. (See Figure 12.)

Main No. 1, Branch 1

Approximately 10,500 feet (stations 0 to 105) of channel work will be installed commencing at station 364 on main No. 1 and continuing due south to the southwest corner section 7, T. 146 N., R. 47 W. This channel will convey the runoff from a 17.5 square mile drainage area into main No. 1. The channel design capacity is increased to handle the runoff from the S½ sections 17 and 18 and all of sections 19, 20, and 21, T. 146 N., R. 47 W. The existing culverts would be modified to allow this additional area to drain into main No. 1, branch 1, system. This area is presently in the judicial ditch 53 system. The channel work will widen and deepen the previously man-made channel. The channel work will require the removal of 16 acres of cropland in addition to the 17 acres already in the channel area.

The upper terminus of the channel work is at the road along the north side of section 18, T. 146 N., R. 47 W. which contains the type III wetland.

Main No. 1, Branch 2

Approximately 21,400 feet (stations 0 to 214) of channel work will be installed commencing at station 682 on main No. 1. The channel work will go south on the east side of County Road 134 and stay east of the Midwest Pipeline. At station 108, the channel work will continue eastward to the northeast corner, section 17, T. 146 N., R. 46 W. (station 214).

The first 9,900 feet (station 0 to 99) of channel work will widen and deepen the existing field ditch. This will require the removal of 19 acres of cropland in addition to the 11 acres in the field ditch area.

The next 900 feet (station 99 to 108) of channel work will be parallel to the Midwest Pipeline. This will be a new channel and will require the removal of 3 acres of cropland.

The next 10,600 feet (station 108 to 214) of channel work will widen and deepen the existing field ditch. This will require the removal of 20 acres of cropland in addition to the 13 acres in the field ditch area.

At the upper end (station 214) of the channel, grade stabilization structure S-1D (box inlet to culvert) will be installed to drop the runoff water 6 feet into the channel. (See Figure 13.)

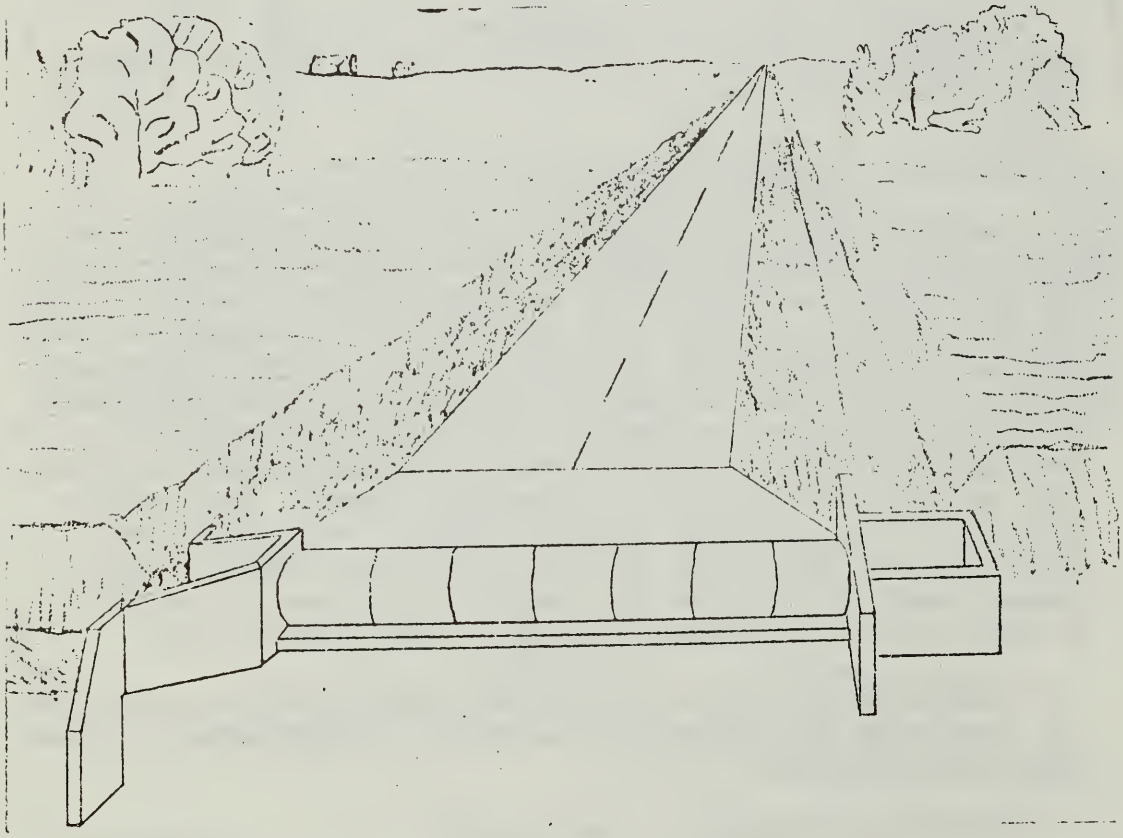

Figure 13. Box Inlet to Culvert.

Main No. 2

Approximately 35,500 feet (station 0 to 355) of channel work will be installed, commencing at the Red River on the north side section 12, T. 146 N., R. 49 W., and continuing due east to the northeast corner section 12, T. 146 N., R. 48 W.

Between stations 0 and 3 (300 feet), grade stabilization structure S-2 (chute spillway), along with 100 feet of structure outlet channel, will be constructed to drop the water 33 feet to the normal water level of the Red River. This will require the removal of 3 acres of forest land.

The next 400 feet (stations 3 to 7) will consist of filling and shaping the existing eroded condition to provide a new stable

channel. The fill material will be obtained from the excavation of the grade stabilization structure S-2 and outlet channel. The land required is the 1 acre presently used as the channel area.

Continuing upstream a distance of 34,800 feet (stations 7 to 355), the work will widen and deepen the previously man-made channel. The channel work will require the removal of 54 acres of cropland in addition to the 39 acres already in the channel area.

Nonstructural Measures

Cultural Assessment

A cultural (historic, archeological, architectural) assessment of Norman-Polk Watershed will be conducted prior to beginning construction. A contract will be negotiated with the Minnesota Historical Society to conduct this survey and assessment. If affected cultural resources are encountered prior to or during construction, a salvage and/or preservation program will be developed in association with the Sponsors, Soil Conservation Service, Minnesota Historical Society (State Historic Preservation Officer), and U.S. Department of the Interior, National Park Service.

TABLE E - PLANNED CHANNEL WORK

Channel	Station	Drainage Area (Sq. Mi.)	Bottom Width (Feet)	Depth[1] (Feet)	Present Land Use Channel (Acres)	Present Land Use Crop (Acres)	Land Rights[2] (Acres)	Type of Work[3]	Type of Channel[4]	Flow Condition[5]	Road Adjacent to Channel
Main No. 1--	19 to 22	Grade stabilization structure S-1				[6]1	3	I	O	E	No
	22 to 28	73.3	32	4.3	0	3	3	I	O	E	No
	28 to 50	73.3	32	6.2	6	4	11	V	M	I	No
	50	Grade stabilization structure S-1A----------						V	M	I	Yes
	50 to 99	72.8	32	6.2	12	7	20	V	M	I	Yes
	99 to 100	Reach between Burlington North RR. and U.S. Hwy. 75 will be riprapped----------									
	100	Grade stabilization structure S-1B----------						V	M	I	Yes
	100 to 205	70.7	24	7.1	24	12	39	II	M	I	Yes
	205 to 259	67.9	18	7.5	13	6	20	II	M	I	Yes
	259 to 364	67.9	18	7.5	24	18	47	II	M	I	No
	364 to 682	46.7	18	6.1	51	61	127	II	M	E	No
	682 to 820	21.9	4	6.0	22	24	52	II	M	E	No
	820	Grade stabilization structure S-1C----------						II	M	E	No
	820 to 840	18.2	4	3.5	3	4	8	II	M	E	No
Total Main No. 1----------					155	140	330				
Main No. 1, Branch 1	0	Junction with main No. 1 at station 364----------									
	0 to 52	17.5	4	6.0	8	10	20	II	M	E	No
	52 to 105	16.6	4	4.8	9	6	16	II	M	E	Yes
Total Main No. 1, Branch 1----------					17	16	36				
Main No. 1, Branch 2	0	Junction with main No. 1 at station 682----------									
	0 to 52	17.9	16	4.6	6	12	20	II	M	E	No
	52 to 80	17.9	16	4.6	3	4	8	II	M	E	Yes
	80 to 99	11.5	12	4.6	2	3	6	II	M	E	Yes
	99 to 108	11.5	12	4.6	0	3	3	I	O	E	No
	108 to 214	11.1	4	3.5	13	20	38	II	M	E	No
	214	Grade stabilization structure S-1D----------						II	M	E	No
Total Main No. 1, Branch 2----------					24	42	75				

See footnotes at end of table, p. 39.

TABLE E - PLANNED CHANNEL WORK--Continued

Channel	Station	Drainage Area (Sq. Mi.)	Bottom Width (Feet)	Depth[1] (Feet)	Present Land Use: Channel (Acres)	Present Land Use: Crop (Acres)	Land Rights[2] (Acres)	Type of Work[3]	Type of Channel[4]	Flow Condition[5]	Road Adjacent to Channel
Main No. 2--	0 to 3	Grade stabilization structure S-2				(7)	3	V	M	E	Yes
	3 to 7	4.6	6	2.5	1	-------	1	V	M	E	Yes
	7 to 92	4.7	6	2.5	9	14	25	II	M	E	Yes
	92 to 355	3.1	4	3.0	30	40	76	II	M	E	Yes
Total Main No. 2----------					40	54	105				
Grand Total----------					236	252	546				

1/ Design flow depth

2/ This area (546 acres) is the total land rights required for the construction, operation, and maintenance of the structural measures. The land use is 236 acres of existing channel area, 252 acres of cropland, and 5 acres of forest land. There is an additional 53 acres that will continue to be cropped.

3/ I - Establishment of new channel including necessary stabilization measures.
II - Enlargement of realignment of existing channel or stream.
V - Stabilization as a primary purpose.

4/ M - Man-made ditch or previously modified channel.
O - None or practically no defined channel.

5/ E - Ephemeral - flows only during periods of surface runoff, otherwise dry.
I - Intermittent - continuous flow through some seasons of the year, but little or no flow through other seasons.

6/ There are 2 acres of forest land in addition to the cropland acres in this reach.

7/ There are 3 acres of forest land in this reach.

EXPLANATION OF INSTALLATION COST

Land Treatment Measures

The total cost of installing land treatment measures is $697,200. The cost of applying the measures, $584,400, will be met by the landowners and operators on whose farms the measures will be installed. Cost-sharing from other programs, such as the Rural Environment Conservation Program, may contribute part of the application cost. Technical assistance for the application of these measures is estimated at $112,800 of which $72,100 will be provided by Public Law 83-566 funds. Included in the Public Law 83-566 funds is $1,500 for the completion of soil surveys in the watershed. The remaining $40,700 will be provided from the existing going programs of the Soil Conservation Service, the Forest Service, and the Minnesota Department of Natural Resources, Division of Lands and Forestry. Land treatment cost is summarized in Table 1, page 57.

Cost estimates of installing land treatment measures on cropland and pastureland are based on average costs presently encountered for their installation in the area. Costs for needed technical assistance are based on summary cost data of the Soil Conservation Service.

The costs for installation of the forest land treatment measures are based on current costs of supervision, labor, equipment, and materials needed to perform the particular measures. The costs of technical assistance, for installation of the forest land treatment measures, for the preparation of management plans, and other federal information and education activities, are based on actual expenditures and accomplishments of the Minnesota Department of Natural Resources, Division of Lands and Forestry.

The schedule of estimated land treatment costs, needed for each fiscal year during the installation period, is as follows:

Fiscal Year	Public Law 566 Funds	Other Funds
First	$20,000	$95,000
Second	20,000	130,000
Third	12,000	150,000
Fourth	10,000	120,000
Fifth	5,100	75,000
Sixth	5,000	55,100
Total	$72,100	$625,100

Structural Measures

The total installation cost for structural measures include all construction, engineering, land rights, and project administration costs paid by both Public Law 83-566 and by other funds. They are shown in detail in Table 2, Page 60.

The cost was allocated between flood prevention and drainage on the basis of the areal relationship of wetland in the area benefited by the multiple purpose channel compared to the total drainage area of the channel. The benefited wetland area is 20 percent of the total drainage area. The wetland increment was allocated to flood prevention. Total cost allocation to flood prevention is 90 percent and the cost allocation to drainage is 10 percent.

Construction Costs

Construction costs are the engineer's estimates of all materials and labor involved in constructing the measures. Items included are: furnishing materials, clearing and obstruction removal, excavation, concrete placements, seeding, fencing, placing of riprap, and other necessary work. Unit costs were calculated on the basis of current prices for similar construction work in Minnesota. A 12 percent contingency allowance is added to defray any additional cost that might arise during construction.

Total construction cost for the structural measures is estimated at $1,074,600. This includes $1,054,600 project cost and $20,000 non-project cost. The construction cost of the multipurpose channel is estimated at $728,600 and the grade stabilization structures are estimated at $346,000.

Grade stabilization structure with an estimated cost of $53,000 is designed to include a road crossing. The road crossing deck and approach fill is estimated to cost $20,000 or 37.7 percent of total cost. This is a non-project cost to be paid by other funds.

Public Law 83-566 funds will pay 100 percent of the construction cost allocated to flood prevention and 50 percent of the cost allocated to drainage.

Grade stabilization structure S-1A will be cost-shared with Public Law 83-566 funds estimated at $31,300 or 59.1 percent, and other funds will pay $21,700 or 40.9 percent. The other fund costs include $1,700 project cost and $20,000 non-project cost.

The construction cost of the multipurpose channel and the other 5 grade stabilization structures will have 95 percent cost-sharing with Public Law 83-566 funds and 5 percent with other funds. The Public Law 83-566 share is $970,300 while the other than Public Law 83-566 share is $51,300.

Engineering Services

Project engineering services are paid 100 percent from Public Law 83-566 funds. They include cost for required surveys, engineering and geologic investigations, design, and preparation for plans and specifications for all project structural measures. Estimated cost is $127,000.

Engineering services necessary for the non-project features of grade stabilization structure S-1A amount to $3,000 and will be paid from other funds. This cost amounts to 25 percent of the total engineering services for the structure, including the project and non-project engineering services cost. These services consist of coordinating the engineering design of the structure between the County Highway Department and the Service.

Relocation Payments

Investigations have disclosed that under present conditions, the structural measures will not result in the displacement of any person, business or farm operation. However, if relocations become necessary, relocation payments will be cost-shared with 58.6 percent Public Law 83-566 funds and 41.4 percent other funds. Items that would be eligible for relocation payment include moving and related expenses and replacement housing.

Project Administration

Public Law 83-566 project administration costs include the cost of administration, review of engineering plans developed by others, construction surveys, government representatives, necessary inspection services during construction, the administrative functions as may become necessary in connection with relocation payments, and assisting the Sponsors with relocation assistance advisory services. The total Public Law 83-566 project administration costs are estimated to be $141,200.

Other project administration costs include administration of contracts, legal fees, clerical, any construction inspection they may perform, relocation assistance advisory services, and administrative costs associated with making relocation payments.

The relocation assistance advisory services may include determination of replacement needs, providing information on availability of housing and farm operations, assuring replacement dwellings, assisting any displaced person to minimize hardships and become established again, supplying information on federal and state programs offering assistance and providing any displaced person a brochure outlining the benefits they may be entitled to. Administrative functions, in connection with relocation payment, may include serving notice of displacement, providing appropriate

forms, assisting in filling applications, hearing and resolving grievances, and in making relocation payments.

Since no relocation payments are anticipated in the plan, the cost of providing relocation assistance advisory service is not included. Total other project administration services costs are estimated to be $29,300.

Land Rights

Land rights includes costs of obtaining land required for structural measures, modification of roads and driveways, installation of new bridges, and obtaining land for borrow materials. The total cost of land rights for the project measures is estimated at $238,200. Not included in this figure is the non-project cost for providing additional width required for the new bridges. The present bridges are narrower than that required by the State Highway Department for new bridges. Cost for providing the additional width amounts to $13,200. The total land required for the channel improvement is approximately 546 acres. No federal assistance will be provided for any of the land rights costs incurred by the local organization.

Cost-Sharing

The entire cost of the structural measures is estimated to be $1,590,300. The Public Law 83-566 share is $1,269,800 or 80 percent of the total. The other than Public Law 83-566 share is $320,500 or 20 percent. Non-project costs, estimated to be $36,200, are in addition to the other than Public Law 83-566 costs. See cost summaries in Tables 1, 2, and 2A; Pages 57, 58, 60, and 61. The schedule of estimated structural project costs needed for each fiscal year during the installation schedule is as follows:

Installation Schedule

Fiscal Year	Public Law 566 Funds	Other Funds	Prepare Engineering Court Plans	Watershed Hearings, Contract Plans and Specs., Obtain Other Than Public Law 566 Monies	Award Contract and Construct
First	$5,000	$5,800	S-1, S-1A S-1B, S-1C S-1D, Main No. 1 Br. 1 & Br. 2		
Second	95,000	20,000 (3,000)		S-1, S-1A S-1B, S-1C, S-1D, Main No. 1 Br. 1 & Br. 2	
Third	256,000	84,600 (28,400)			Main No. 1 outlet to U.S. Hwy. No. 75, S-1, S-1A, S-1B
Fourth	290,000	126,500 (4,800)	Main No. 2, S-2		Approx. ½ Main No. 1 & Br. 1
Fifth	385,600	70,800		Main No. 2 and S-2	Approx. ½ Main No. 1 Br. 2, S-1C, S-1D
Sixth	238,100	12,500			Main No. 2 and S-2
TOTAL	$1,269,800	$320,500 (36,200)			

EFFECTS OF WORKS OF IMPROVEMENT

Conservation Land Treatment

The application of soil and water conservation practices will increase the amount of land adequately treated. The increase of land adequately treated is as follows:

Land Use	Land Adequately Treated Before Project (Acres)	Land Adequately Treated After Project (Acres)
Cropland	19,400	46,150
Pastureland	600	2,100
Forest land	180	250
Other land (used primarily for wildlife)	500	950

This will increase the land adequately treated from 20,680 to 49,450 acres, or 68 percent of the watershed.

Along the area that the field windbreaks are installed, the maximum soil loss will not exceed 4 tons per acre in any given year. This will reduce the potential wind erosion from 20 to 4 tons per acre on 12,000 acres.

The wind and water erosion will be reduced with the application of conservation practices. These practices will reduce the average annual erosion from 1.1 to 0.8 ton per acre.

The major source of plant nutrient pollutants (N,P,&K) is by soil erosion. Soil transported by wind or water erosion into the drainage system carries with it these nutrients. With soil erosion being reduced by the application of conservation practices, the nutrients will therefore be reduced in a similar proportion.

The land treatment measures will reduce the sedimentation from wind and water erosion. This sedimentation outflow will be reduced from 18,000 to 13,500 tons per year, a reduction of 4,500 tons per year.

This additional adequately treated land will improve wildlife habitat. Such practices as minimum tillage, conservation cropping systems, crop residue management, and tree planting will increase available food and cover. The system of field windbreaks (at least 110 miles) will reduce wind

velocity throughout the area, while providing travel lanes, escape cover, and other types of habitat for most wildlife species.

The application of many land treatment practices, such as field windbreaks, tree planting, farm ponds, and wetland wildlife area development, will provide 800 acres of additional scenic area to add variety to featureless lake plain area.

Structural Measures

The planned structural measure is limited to the judicial ditches 52 and 54, lateral 1, system. No structural measures are planned on the judicial ditch 53 system.

Flooding is presently occurring on the average of once every year. With the structural measures, the frequency of flooding will be less than once every 5 years.

The area flooded from a 5-year frequency flood will be reduced from 18,200 to 0 acres.

The flood damages on 18,700 acres of crops will be reduced by 68 percent.

Other agricultural damages directly related to flooding will be reduced 85 percent. These benefits include reduction of damages to buildings, machinery, and grain storage, as well as reduced cost for debris removal and weed control.

The road and bridge damage due to flooding will be reduced by 56 percent on 12 bridges and 8,400 feet of road.

A stable channel will replace 11,800 feet of active eroding channel near the outlets. The land voiding will be reduced from 0.7 to 0 acre per year on judicial ditch 52 and 0.05 to 0 acre per year on judicial ditch 54, lateral 1, by preventing the occurrence of bank sloughing. The annual soil loss on judicial ditch 52 will be reduced from 14,000 to 0 tons and on judicial ditch 54, lateral 1, will be reduced from 1,000 to 0 tons. The stable channel will also safeguard a U.S. highway, railroad bridge, telephone cable, electric lines, 2 township roads, and a cemetery revetment recently installed. Soil erosion and sedimentation will be controlled along the channel with the installation of the pipe inlets.

The structural measures will reduce the average annual sediment load delivered to the Red River from 19,500 to 4,500 tons. The land treatment and structural measures combined will reduce the sediment delivered to the Red River from 37,500 to 18,000 tons per year, or 0.52 to 0.25 ton per acre

per year. This will reduce the turbidity of the Red River at this point and will improve the water quality for downstream users.

The indirect damages from flooding will be reduced by about 71 percent. These benefits would reduce the loss of production time, decrease extra travel, and reduce the delays of conducting business.

The structural measures will reduce the present flood and erosion damages within the watershed by 71 percent on 20,000 acres, affecting 85 farm units located adjacent to mains No. 1 and 2. The total damage reduction is 73 percent, which includes the damage reduction from the land treatment measures.

Four thousand acres of cropland, presently subject to prolonged wetness conditions, will be provided with improved drainage outlets provided by the installation of mains No. 1 and 2. Drainage of these cropland areas will allow earlier planting of crops, more latitude in the choice of crops grown, and more efficient farming operations.

With improvement in drainage and reduction of floodwaters on the land affected by the channel work, the land will be more intensively cropped and greater quantities of plant nutrients (N,P,&K) will be applied. As a result, the reduced sediment volume entering the drainage system will carry with it a slightly higher concentration of plant nutrients (N,P,&K) per ton of sediment. However, due to the application of land treatment, improved drainage, and reduced floodwaters, the vegetative cover will be improved and the organic matter in the soil will be increased. The added nutrients will be more readily utilized by plant growth. The improved plant growth will provide needed residue to reduce erosion, sedimentation, and nutrient pollution in the drainage system.

Spoil material will be spread over approximately 55 acres that will remain in cropland. This spoil material will have a low level of fertility and poor tilth resulting in reduction of crop yields. Through repeated fertilization and crop residue incorporation, yields will gradually increase, so that at the end of a 5-year period, crop production will be nearly comparable to adjacent cropland.

The vegetative plantings (450 acres), along the channel side slopes, berms, and spoil banks, will provide travel lanes, escape cover, food, and other types of habitat for wildlife species.

Excavation of channels will destroy the existing vegetation which will disrupt upland game and other wildlife habitat in the area until new vegetation is established. Some wildlife will be destroyed by construction equipment.

Should a runoff-producing storm occur immediately after construction, before mulching is completed, the channels will be subject to erosion. This would also cause increased amounts of sediment to be delivered to the Red River. The installation of the grade control structures and the filling of two eroded outlet channels will eliminate the sediment derived from bank erosion. This will more than compensate for the sediment that may be generated by channel construction. The net effect of construction activity on sediment outflow from the watershed will be a reduction.

The maintenance of the structural measures will keep the project performing as designed throughout the 50-year evaluated life of the project. This maintenance will be performed in a manner that will control the erosion and sedimentation.

The enlargement and improved hydraulic efficiency of mains No. 1 and 2 will increase the discharge to the Red River. The present effective channel capacity, immediately upstream of eroding reach on main No. 1, is 230 cubic feet per second. The improved flood-free discharge will be increased to 680 cubic feet per second.

The drainage area of the Red River at the confluence of mains No. 1 and 2 is approximately 23,300 square miles, compared to 78 square miles in the watershed. The 5-year frequency discharge on the Red River is estimated at 18,500 cubic feet per second. The maximum increase in discharge on the Red River would be from 18,500 to 18,950 cubic feet per second. However, this amount of increase would only occur when the two peak discharges meet at the same time. During the majority of times the change of peak discharge is insignificant since the watershed discharge would precede the peak discharge of the Red River.

The design of main No. 1 will include four sections of land from judicial ditch 53 system. This in turn will have a net reduction of four sections of land in the existing judicial ditch 53 system, thereby reducing the floodwater volumes in the lower reaches.

The snow that is removed from the roadways during the winter months by the snow removal equipment will be on the berms of the channels and not in the channel. However, there can be wind-blown snow deposited in the channel. The reduction of snowpack from the roadways in the main channels will allow them to open up earlier in the spring. This will allow the runoff from snowmelt from the fields to be removed in a more timely manner.

The land use changes expected to occur are summarized in the following table:

Table F - Expected Changes in Land Use with Installation of Project - Acres

Item	Cropland	Pasture	Forest	Other	Total
Without Project	65,300	2,200	355	4,645	72,500
With Project	65,048	2,200	350	4,902	72,500
Change	-252	-------	-5	+257	------

The removal of vertical side slopes in the eroded portions of judicial ditch 52 and judicial ditch 54, lateral 1, with berms and spoil banks will reduce the existing hazard of operating farm machinery along these side slopes.

Increased crop production expected to occur on the average annual acre basis in the benefited area (11,700 acres) is summarized in the following tables:

Table G - Estimated Projected Crop Yields Per Average Annual Acre in Benefited Area

Crop	Unit	Without Project Yields	With Project Yields
Wheat	bu	30.0	40.0
Barley	bu	35.0	50.0
Oats	bu	50.0	70.0
Flax	bu	10.0	17.0
Corn	bu	40.0	55.0
Soybeans	bu	12.0	18.0
Sunflower	cwt	10.0	13.5
Sugar beets	tons	10.0	16.0
Hay	tons	2.5	3.5

Table H - Estimated Annual Increase in Projected Crop Yields in Benefited Area

Crop	Unit	Increased Production
Wheat	bu	26,000
Barley	bu	35,000
Oats	bu	32,500
Flax	bu	2,500
Corn	bu	5,000
Soybeans	bu	3,500
Sunflower	cwt	4,000
Sugar beets	tons	700
Hay	tons	700

Economic and Social

Greater efficiency in agricultural commodity production will occur as a result of reduced flood damages and improved drainage conditions. Fields can be seeded earlier and in larger units. Replanting will be reduced. The use of larger machinery, made possible by more uniform field conditions, will also aid in achieving greater efficiency in food production. Incomes and standards of living will improve.

The annual reduction of crop, other agricultural, gully erosion, and indirect damages, as well as the more intensive land use and drainage benefits, will increase farm income approximately $100,000 for 85 land users or an average of $1,175 each. The additional benefit of $1,175 for each land user will increase the value of farm products sold, improve the economic base, increase per capita income, and provide the basis for further rural area development. These items will be further improved by the annual reduction of flood and gully damages to roads and bridges and indirect damages. This benefit will approximate $14,800 and will accrue to the local citizens in the form of reduced private, county, and township expenses.

Secondary effects will accrue to the local processor and handlers of the additonal produced crops, livestock, and livestock products, as well as to those providing inputs such as seed, fertilizer, machinery, etc., needed for the increased production.

Traffic will be reduced or eliminated on six township roads due to the removal of bridges and culverts. This will increase traffic on adjacent roads. Four field drive channel crossings will be eliminated which will cause inefficiency in some farming operations. Thirteen existing bridges and culverts will be

replaced with larger structures which will reduce flooding over roads at these locations. Through traffic will be provided with the installation of a bridge on a township road presently without a crossing.

The construction of the project will provide approximately 80 man-years of employment of which 15 to 20 man-years would involve the locally unemployed and underemployed. The project will provide from 1.5 to 2 man-years of employment annually of the unemployed and underemployed.

The establishment of grass strips (450 acres) along each side of the channel, along with the field windbreaks, will provide additional open space with aesthetic appearances. The graves in the cemetery, adjacent to main No. 1 and Highway No. 75, will be protected against erosion damage with the installation of the grade stabilization structure and riprap. The improved livability within the watershed will provide more incentives for the present population to remain in the area.

The removal of approximately 252 acres of cropland from agricultural production, for channels and structure sites, will reduce total net income of the farm operators by $5,100 annually. Secondary effects from the reduced acreage will also accrue to the local processors, handlers, and dealers in the form of reduced sales. However, the loss is more than offset by increased production on the benefited acreage.

The forest land will provide native vegetation, wildlife habitat, recreation, protection of the flood plain, and limited wood production.

The development of conservation and forest management plans will provide a base for the conservation use and treatment of soil and water resources of the land unit.

PROJECT BENEFITS

The benefits of this project are to people; those within the watershed, in adjacent areas, and along main street in the local communities. This project will assist in stabilizing the income of the family farms affected by the flooding condition. This, in turn, bolsters the total economy of the area. Tax dollars spent for road and bridge repair due to flood damage will be reduced. This benefits each taxpayer.

The major benefits from flood prevention result from more timely seeding and reduction in crop losses from summer flooding. This amounts to $84,260 annually.

Reduction in other agricultural damages, directly related to flood prevention, is $6,260. The majority of this benefit is from the control of noxious weeds spread by low velocity overland flows. The remaining benefit is from reduction in damage to stored grain, farmsteads, and removal of debris. Reduction in flood damages to road and bridges is estimated to equal $940 annually. Indirect benefits are estimated to be $10,470.

Annual benefits from streambank erosion control amounts to $12,830, including $7,600 for the railroad and Highway No. 75 bridges, $1,950 for the cemetery wall, $1,150 for the township roads, $1,080 for road and side inlet culverts, $550 for electric lines and telephone cables, and $500 for land voiding adjacent to the channel.

Average annual land enhancement benefits will amount to $11,450. The benefits will accrue on existing cropland, which will be farmed more intensively due to the reduction of frequent flooding. Providing outlets for surface drainage of 4,000 acres of cropland, with prolonged wetness problems, will provide $14,170 average annual benefits.

Primary benefits, that will accrue with the structural measures, are estimated to equal $137,450 annually. These benefits were derived from the reduction of flood damages ($111,830), from more intensive land use ($11,450), and from improved drainage outlets ($14,170). In addition, the installation of land treatment measures will provide $2,930 flood damage reduction benefits.

Secondary benefits that will accrue to local processors and handlers of watershed produced goods and services will equal an additional $16,600. Redeveloped benefits from the use of unemployed and underemployed for the construction, operation, and maintenance of the works of improvement will, likewise, equal an additional $9,250. Secondary benefits, from a national viewpoint, were not considered pertinent to the economic evaluation.

Total annual benefits, including secondary and redevelopment benefits from the installation of the structural works of improvement, will approximate $163,300. The flood prevention purpose will account for benefits of $146,500 and the drainage purpose for the remainder or $16,800. See Table 5 and 6 for evaluated benefits, pages 69 and 70.

COMPARISON OF BENEFITS AND COSTS

The total estimated structure cost for flood prevention and drainage is $1,590,300. (Table 2 and 2A.) This cost, when amortized for fifty years at 5-3/8 percent interest, yields an annual equivalent cost of $92,200. The average annual cost of the operation and maintenance is estimated at $22,150. (Table 4.) The total annual cost for structural measures, including operation and maintenance, amounts to $114,350.

When the project is installed and operating, the estimated average annual benefits are $163,300. (Table 6.) The ratio of the annual benefits to annual cost is 1.4:1. When secondary benefits are not included the benefit cost ratio is 1.3:1.

PROJECT INSTALLATION

The West Polk and East Agassiz Soil and Water Conservation Districts, Polk and Norman County Board of Commissioners, and the Wild Rice Watershed District are the local sponsoring organizations and will be responsible for accomplishing this plan.

The educational phase of the program will be carried out by the Soil and Water Conservation Districts, cooperating with the Extension Service, through dissemination of general information to individuals and local groups. They will prepare radio and press releases and use other means such as tours and demonstrations for acquainting and assisting landowners and operators to understand, and thereby increase participation in carrying out the land treatment and structural measures for flood prevention and erosion control.

The land treatment measures, including forestry measures, will be completed by the landowners and operators in the district. Technical assistance for planning and applying open land practices will be provided by the Soil Conservation Service and forestry practices by the Minnesota Department of Natural Resources, Division of Lands and Forestry, in cooperation with the U.S. Forest Service. Financial assistance from the Rural Environmental Conservation Program for the installation of land treatment measures will be utilized, when applicable. A six-year installation period is proposed for this project.

The Wild Rice Watershed District will be responsible for securing land rights for the structural measures. They have the power of eminent domain and taxation by law.

The Wild Rice Watershed District will administer the contracts for installation of works of improvement. Construction contracts can be let for the structural measures in a unit, after the needed land rights have been secured and the land treatment requirements have been met in that unit. The land treatment requirement consists of installing a system of field windbreaks, either parallel or perpendicular to the channel improvement, on at least 50 percent of the land 1 mile north and west of the channel and ½ mile south and east of the channel. Additional conservation practices installed and conservation plans will be required on 50 percent of the area adjacent to the channel to obtain the adequate land treatment requirement for the structural measures.

All grade stabilization structures will be constructed prior to, or simultaneously with, their associated channel improvement. The installation schedule for the structural measures is shown on page 44.

Seeding and mulching will be done under prime contract for erosion control during construction.

The construction of all structural measures in the plan will comply with federal, state, and local regulations concerning air and water pollution.

Engineering service including investigations, surveys, design construction specifications, geologic investigations, and analysis for structural measures, except those included under land rights, and other engineering non-project cost for grade stabilization structure S-1A, will be provided by the Soil Conservation Service. Engineering services for the bridges and roads will be the responsibility of the Sponsors and will be paid for from other than Public Law 83-566 funds.

Supervision of construction will be provided by the Soil Conservation Service on those items that are cost-shared with Public Law 83-566 funds.

FINANCING PROJECT INSTALLATION

The West Polk and East Agassiz Soil and Water Conservation Districts will encourage the acceleration of land treatment and forestry measures. The estimated cost of installing these measures is $697,200. The cost to landowners and operators is $584,400. It is expected they will be reimbursed for a portion of this cost through the Rural Environmental Conservation Program.

The present level of technical assistance, amounting to $40,700, will be supplemented by Public Law 83-566 funds so that needed land treatment and forestry measures can be planned and applied during the installation period.

Technical assistance for the forestry measures will be cost-shared between the Forest Service and the Minnesota Department of Natural Resources. Accelerated technical assistance to be provided by Public Law 83-566 funds is $72,100.

The total costs of the structural measures to be paid by other funds, $320,500, will be raised by the Sponsors in accordance with State Statutes, by assessment of the benefited land as determined by the appraisers. The assessment per acre will vary as determined by the appraisers.

When State Statute requirements have been met, the Soil Conservation Service will make available Public Law 83-566 funds for the construction of structural works of improvement. Estimated project installation cost is tabulated in Table 1, showing Public Law 566 and other (local) funds. The construction units are shown in Table 7. Construction may commence in a construction unit before all requirements for the entire project have been met.

Federal assistance for carrying out the works of improvement, as described in the work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566, 83d Congress 68 Stat. 666), as amended. All federal assistance obtained for Public Law 83-566 is contingent on Congressional appropriation of necessary funds.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The land users are responsible for the operation and maintenance of all conservation practices installed on their land. These practices will be operated and maintained in a manner that will insure their normal life expectancy and maintain allowable soil loss tolerances. Technical assistance is available from the Service through the local soil and water conservation districts.

Structural Measures

An operation and maintenance agreement for the structural measures will be executed between the Sponsors and the Service prior to signing a project agreement. The Wild Rice Watershed District will be responsible for financing and implementing the maintenance work. Funds for the maintenance work will be obtained by assessments to the beneficiaries. The maintenance will be performed in a timely, adequate, and appropriate manner to assure efficient operation and functioning of the works of improvement for the 50-year evaluation period of the project. Annual expenses of operation and maintenance are estimated at $22,150.

Channel maintenance will include periodic cleanouts and control of weeds and other vegetation. Cleanouts include removal of sediment deposits and debris. Weed and vegetation control will be accomplished by mowing and chemical application within state and federal regulations. Other channel maintenance may include repairing eroded channel banks, channel bottoms, berms, spoil banks, and repair of surface inlets. Mowing and chemical controls will be delayed until after July 15.

The maintenance of the grade stabilization structures may require the repair of earth fills, removal of debris, replacement of riprap, the replacement of corrugated metal pipes, and any

repair necessary to concrete structures. Operation and maintenance will also include the normal repair of bridges and culverts to maintain a stable channel of design capacity.

The operation and maintenance agreement will include provisions for joint inspections by the Sponsors and a representative of the Service during the first 3 years after the installation of the structural measures. After the 3-year period, the Sponsors will make these inspections. Inspections will also be made after unusually severe floods and any other unusual conditions which could adversely affect the structural measures.

The Sponsors will furnish annual inspection reports to the Service.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Norman-Polk Watershed, Minnesota

Installation Cost Item	Unit	Number to be Applied Non-Fed. Land	Estimated Cost (Dollars) 1/ P.L. 566 Funds Non-Federal Land SCS 3/	F.S. 3/	Total	Other Funds Non-Federal Land SCS 3/	F.S. 3/	Total	Total
LAND TREATMENT									
Land Areas 2/									
Cropland	Ac.	26,750				549,800		549,800	549,800
Pastureland	Ac.	1,500				15,000		15,000	15,000
Forest Land	Ac.	70					12,100	12,100	12,100
Other Land	Ac.	450				7,500		7,500	7,500
Technical Assistance			66,200	5,900	72,100	39,600	1,100	40,700	112,800
TOTAL LAND TREATMENT	Ac.	28,770	66,200	5,900	72,100	611,900	13,200	625,100	697,200
STRUCTURAL MEASURES									
Construction									
Grade Stabilization Structures	No.	6	309,500		309,500	16,500		16,500	326,000
Channel Work 4/									
(M)	Mi.	27.9	684,900		684,900	36,100		36,100	721,000
(O)		0.3	7,200		7,200	400		400	7,600
Subtotal - Construction			1,001,600		1,001,600	53,000		53,000	1,054,600

See footnotes at end of Table 1.

TABLE 1 (continued)

Installation Cost Item	Unit	Number to be Applied Non-Fed. Land	Estimated Cost (Dollars) 1/ P.L. 566 Funds Non-Federal Land SCS 3/	F.S. 3/	Total	Other Funds Non-Federal Land SCS 3/	F.S. 3/	Total	Total
Engineering Services			127,000		127,000				127,000
Project Administration									
Construction Inspection			71,400		71,400	5,900		5,900	77,300
Other			69,800		69,800	23,400		23,400	93,200
Subtotal - Administration			141,200		141,200	29,300		29,300	170,500
Other Costs									
Land Rights						238,200		238,200	238,200
TOTAL STRUCTURAL MEASURES			1,269,800		1,269,800	320,500		320,500	1,590,300
TOTAL PROJECT			1,336,000	5,900	1,341,900	932,400	13,200	945,600	2,287,500

1/ Price base - 1973.
2/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.
3/ Federal agency responsible for assisting in installation of works of improvement.
4/ Type of channel before project: (M) Manmade ditch or previously modified channel.
(0) None or practically no defined channel.

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(Through June 30, 1973)

Norman-Polk Watershed, Minnesota

Measures	Unit	Applied to Date	Total Cost Dollars 1/
LAND TREATMENT			
Public Recreation Development	No.	1	2,000
Conservation Cropping System	Ac.	36,660	183,300
Critical Area Planting	Ac.	114	11,400
Crop Residue Management	Ac.	23,250	70,000
Dikes	Ft.	2,600	2,600
Ponds	No.	10	5,000
Farmstead-Feedlot Windbreak	Ac.	67	16,700
Field Windbreak	Ft.	212,800	9,000
Grade Stabilization Structures	No.	87	43,500
Grass Waterway/Outlet	Ac.	1	500
Drainage Land Grading	Ac.	40	4,000
Land Smoothing	Ac.	600	60,000
Minimum Tillage	Ac.	6,200	6,200
Drainage Main & Lateral	Ft.	124,000	47,000
Pasture & Hayland Management	Ac.	1,360	13,600
Pasture & Hayland Planting	Ac.	280	7,000
Structure for Water Control	No.	27	13,500
Drainage Field Ditch	Ft.	1,010,000	307,000
Wildlife Wetland Management	Ac.	22	300
Wildlife Habitat Management	Ac.	530	8,000
Cropland to Grassland Conversion	Ac.	23	500
Cropland to Woodland Conversion	Ac.	45	11,300
Cropland to Wildlife-Rec. Conversion	Ac.	5	100
Cropland to Other Conversion	Ac.	130	6,500
Non-Crop to Wildlife-Rec. Conversion	Ac.	40	600
Forest Fire Control	Ac.	355	400
TOTAL			830,000

1/ Price Base 1973

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Norman-Polk Watershed, Minnesota

(Dollars) 1/

Item	Installation Cost PL-566 Funds			Installation Cost-Other Funds				Total Installation Cost
	Construction	Eng. 9/	Total PL-566	Construction	Eng.	Land Rights	Total Other	
Channel Work								
Main No. 1								
22 to 28 (O) 10/	4,000	400	4,400	200		700	900	5,300
28 to 840 (M) 10/	450,300	42,600	492,900	23,700		106,900 2/ (8,400) 7/	130,600	623,500
Grade Stab. Strs.								
S-1 (Sta 19 to 22)	141,800	28,900	170,700	7,500		600 3/	8,100	178,800
S-1A (Sta 50)	31,300	9,000	40,300	1,700 (20,000) 8/	(3,000) 8/		1,700	42,000
S-1B (Sta 100)	2,700	600	3,300	200			200	3,500
S-1C (Sta 820)	22,500	4,000	26,500	1,200			1,200	27,700
Main No. 1, Branch 1								
0 to 105 (M) 10/	50,200	4,700	54,900	2,700		18,500 4/ (4,800) 7/	21,200	76,100
Main No. 1, Branch 2								
0 to 99 (M) 10/	35,000	3,300	38,300	1,800		28,200	30,000	68,300
99 to 108 (O) 10/	3,200	300	3,500	200		2,500	2,700	6,200
108 to 214 (M) 10/	37,500	3,600	41,100	2,000		30,000	32,000	73,100
Grade Stab. Str.								
S-1D (Sta 214)	14,500	2,600	17,100	800			800	17,900
Main No. 2								
3 to 355 (M) 10/	111,900	10,600	122,500	5,900		50,200	56,100	178,600
Grade Stab. Str.								
S-2 (Sta 0 to 3)	96,700	16,400	113,100	5,100		600	5,700	118,800
Subtotal	1,001,600	127,000	1,128,600	53,000		238,200	291,200	1,419,800
Proj. Administration			141,200				29,300	170,500
GRAND TOTAL	1,001,600	127,000	1,269,800	53,000		238,200	320,500	1,590,300

1/ Price base - 1973.
2/ $27,800 for bridges, $68,100 for land, $11,700 for structure removal and moving utilities
3/ All for land.
4/ $7,500 for bridges, $8,000 for land, $3,000 for structure removal.
5/ $39,100 for bridges and culverts, $15,400 for land, $6,200 for structure removal and moving utilities.
6/ $25,100 for culverts, $17,700 for land, $7,400 for structure removal and moving utilities.
7/ Non-project cost for additional width required of new bridges.
8/ Non-project cost for road crossing with grade stabilization structure - includes $3,000 for non-project engineering costs.
9/ Includes $27,200 for geologic investigations for final design.
10/ Type of channel before project (M) Manmade ditch or previously modified channel.
(O) None or practically no defined channel.

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY
Norman-Polk Watershed, Minnesota
(Dollars) 1/

Item	COST ALLOCATION PURPOSE			COST SHARING P. L. 566			COST SHARING OTHER		
	Flood Prevention	Drainage	Total	Flood Prevention	Drainage	Total	Flood Prevention	Drainage	Total
Channel Work Main No. 1	565,900	62,900	628,800	469,100	28,200	497,300	96,800	34,700	131,500
Stab. Structures S-1	160,800	18,000	178,800	160,300	10,400	170,700	500	7,600	8,100
S-1A	37,700	4,300	42,000	37,700	2,600	40,300	-	1,700	1,700
S-1B	3,000	500	3,500	3,000	300	3,300	-	200	200
S-1C	24,900	2,800	27,700	24,900	1,600	26,500	-	1,200	1,200
Main No. 1, Br. 1	68,400	7,700	76,100	51,700	3,200	54,900	16,700	4,500	21,200
Main No. 2, Br. 2	132,800	14,800	147,600	78,200	4,700	82,900	54,600	10,100	64,700
Stab. Structure S-1D	16,000	1,900	17,900	16,000	1,100	17,100	-	800	800
Main No. 2	160,700	17,900	178,600	115,500	7,000	122,500	45,200	10,900	56,100
Stab. Structure S-2	106,900	11,900	118,800	106,400	6,700	113,100	500	5,200	5,700
TOTAL	1,277,100	142,700	1,419,800	1,062,800	65,800	1,128,600	214,300	76,900	291,200

1/ Price base - 1973

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TABLE 3 - STRUCTURE DATA

CHANNELS

Norman-Polk Watershed, Minnesota

Channel	Sta. 3/	Drainage Area Sq. Mi.	Capacity cfs Req'd.	Capacity cfs Design	Hydraulic Gradient Ft./Ft.	Channel Dimensions 1/ Bottom Width Ft.	Channel Dimensions 1/ Bottom Grade %	Channel Dimensions 1/ Depth Of Flow (Ft.)	Velocities Ft./Sec. Aged	Velocities Ft./Sec. As Built	Excavation (1000 Cu. Yds.)	Type Of Work 4/	Before Project Type Of Channel 5/	Before Project Flow 6/ Conditions
Main No. 1	22	Grade Stabilization Structure S-1												
	28	73.3	680	684	0.0012	32	0.02	4.3	3.2	3.8	8.0	I	O	E
	50	72.8	680	684	0.0007	32	0.02	6.2	1.9	2.7	63.0 2/	V	M	I
	50	Grade Stabilization Structure S-1A												
	99	72.8	680	684	0.0003	32	0.03	6.2	1.9	2.7	28.5 2/	V	M	I
	100	Reach between Burlington Northern R. R. and U. S. Hwy. 75 will be riprapped.										V	M	I
	100	Grade Stabilization Structure S-1B												
	205	70.7	660	681	0.00025	24	0.025	7.1	1.8	2.5	198.8	II	M	I
	364	67.9	660	660	0.00025	18	0.025	7.5	1.8	2.6	239.0	II	M	I
	523	46.7	605	586	0.00045	18	0.045	6.2	2.1	3.2	199.1	II	M	E
	682	43.8	605	604	0.00055	18	0.055	6.0	2.4	3.4	246.9	II	M	E
	788	21.9	340	342	0.00111	4	0.111	5.1	2.7	3.9	163.5	II	M	E
	820	18.2	280	270	0.00015	4	0.015	7.0	1.2	1.8	44.3	II	M	E
	820	Grade Stabilization Structure S-1C												
	840	17.5	270	269	0.0006	4	0.06	3.5	1.9	2.8	12.2	II	M	E
Main No. 1 Branch 1	0	Junction w/Main No. 1 at Sta. 364+00												
	52	17.5	292	302	0.0003	4	0.03	6.0	1.6	2.4	67.5	II	M	E
	105	16.6	195	201	0.0005	4	0.05	4.8	1.8	2.6	61.2	II	M	E
Main No. 1 Branch 2	0	Junction w/Main No. 1 at Sta. 682+00												
	80	17.9	195	194	0.0002	16	0.02	4.6	1.2	1.8	90.0	II	M	E
	99	11.5	163	167	0.0002	12	0.02	4.6	1.2	1.9	18.0	II	M	E
	108	11.5	163	167	0.0002	12	0.02	4.6	1.2	1.9	7.0	I	O	E
	161	11.1	163	157	0.0006	4	0.06	4.2	1.8	2.8	32.6	II	M	E
	214	8.6	78	78	0.001	4	0.1	2.8	1.8	3.0	26.5	II	M	E
	214	Grade Stabilization Structure S-1D												

TABLE 3 - Continued

Channel	Sta. 3/	Drainage Area Sq. Mi.	Capacity cfs Req'd.	Capacity cfs Design	Hydraulic Gradient Ft./Ft.	Channel Dimensions 1/ Bottom Width Ft.	Channel Dimensions 1/ Bottom Grade %	Channel Dimensions 1/ Depth Of Flow (Ft.)	Velocities Ft./Sec. Aged	Velocities Ft./Sec. As Built	Excavation (1000 Cu. Yds.)	Type Of Work 4/	Before Project Type Of Channel 5/	Before Project Flow 6/ Conditions
Main No. 1	3	Grade Stabilization Structure S-2												
	40	4.5	90	94	0.0015	6	0.15	2.6	2.2	3.5	31.0	II	M	E
	92	4.1	80	78	0.0018	6	0.18	2.3	2.3	3.6	30.0	II	M	E
	145	3.1	64	65	0.00025	4	0.025	3.5	1.0	1.7	33.0	II	M	E
	198	2.6	55	52	0.00025	4	0.025	3.1	1.0	1.6	42.0	II	M	E
	250	2.0	45	46	0.00025	4	0.025	3.0	1.0	1.6	40.0	II	M	E
	303	1.3	32	33	0.00035	4	0.035	2.4	0.9	1.7	48.0	II	M	E
	355	0.7	23	24	0.00035	4	0.035	2.1	0.9	1.6	34.0	II	M	E

1/ All channels will have 4:1 side slopes. An "n" value of 0.035 is used for aged channels. An "n" value of 0.025 is used for as-built channels.

2/ Shaping of side slopes and filling bottom of eroded channel to new grade.

3/ Station number is at head of reach - All data represents the reach at this station to preceding station.

4/ I - Establishment of new channel including necessary stabilization measures.
II - Enlargement or realignment of existing channel or stream.
V - Stabilization as a primary purpose.

5/ M - Manmade ditch or previously modified channel. (All channels were originally constructed in approximately 1915).
O - None or practically no defined channel.

6/ I - Intermittent - continuous flow through some seasons of the year but little or no flow through other seasons.
E - Ephemeral - flows only during periods of surface runoff, otherwise dry.

TABLE 3A - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

Norman-Polk Watershed, Minnesota

Site Number	Drainage Area Sq. Mi.	Design Cap. Prin. Spill.	Assoc. Freq. of Storm (% Chance)	Drop Feet	Concrete (Cu. Yds.)	Type of Structure
S-1	73.3	1446	2	35	365	CS 1/
S-1A	72.8	1455	2	8	230	BIDS 2/
S-1B	70.7	1435	2	2	2	RW-BC 3/
S-1C	17.8	620	2	6	90	SD 4/
S-1D	4.0	280	2	6	20	BI&C 5/
S-2	4.6	300	2	33	230	CS 1/

1/ Chute Spillway.
2/ Box Inlet Drop Spillway.
3/ Raised Weir to Box Culvert.
4/ Straight Drop Spillway.
5/ Box Inlet to Culvert.

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TABLE 3B - STRUCTURE DATA

BRIDGES, CULVERTS AND ROADS

Norman-Polk Watershed, Minnesota

Channel	Station	Location	Effect	Reg'd Capacity (cfs) 1/
Main No. 1	50+06	Sec. Cor. 36, 31, 1 & 6, T147/146N, R/49/48W	Install Box Inlet Drop Spillway w/Road rossing. (Old Bridge Washed Out) (Grade Stab. Str. S-1A)	
	99+65	BN-RR Trestle Sec. 6, T146N, R42W	Riprap	1447
	100+35	U. S. Highway 75 - Sec. 31, 32,5, &6, T147/146N, R48W	Install 2.0 Weir (Grade Stab. Str. S-1B)	1447
	153+09	Sec. 32, 33, 4 & 5, T147/146N, R48W	Repair	1435
	204+86	Sec. 33, 34, 3 & 4, T147/146N, R48W	Remove (Bridge)	
	259+20	Sec. 34 & 35, 2, 3, T147/146N, R48W	Satisfactory	
	312+08	Sec. 35 & 36, 2, 1, T147/146N, R48W	Satisfactory	
	364+07	Sec. 36, 31, 1 & 6, T147/146N, R48/47W	Remove (Bridge)	
	415+88	Sec. 31, 32, 5 & 6, T147/146N, R47W	Remove (Bridge)	
	470+80	Sec. 32, 33, 4 & 5, T147/146N, R47W	Replace Bridge	1315
	522+74	Sec. 33, 34, 3 & 4, T147/146N, R47W	Remove (Bridge)	
	575+54	Sec. 34, 35, 2 & 3, T147/146N, R47W	Replace Bridge	1315
	628+91	Sec. 35 & 36, 1, 2, T147/146N, R47W	Remove (Culvert)	
	681+81	Sec. 36, 31, 1 & 6, T147/146N, R47/46W	Remove (Bridge)	

TABLE 3B - Structure Data (Continued) - 2

Channel	Station	Location	Effect	Reg'd 1/ Capacity (cfs)
Main No. 1	786+73	BN-RW, Sec. 32, 5, T146/147N, R46W	Satisfactory	
	788+24	FAS No. 9, Sec. 32, 33, 4, 5 T146/146N, R46W	Satisfactory	
	840+22	Sec. 33, 34, 3, 4, T147/146N, R46W	Satisfactory	
Branch 1	52+23	Sec. 1, 6, 7 & 12, T146N, R47/48W	Replace Bridge	753
	104+59	Sec. 12, 13, 7 & 18, T146N, R47/48W	Replace Bridge	490
Branch 1	0+30	Field Drive - Sec. 6, T146N, R47/46W	Remove (Culvert)	
	52+58	Sec. 1, 12, 6 & 7, T146N, R47/46W	Replace Bridge	536
	108+45	Sec. 7, 18, T146N, R46W	Install Culvert	536
	161+24	Sec. 7, 8, 17 & 18, T146N, R46W	Replace (w/culvert)	536
	199+47	Sec. 17, 18, (CN-RR) T146N, R46W	Replace (w/culvert)	280
	214+20	Sec. 8, 9, 16 & 17, T146N, R46W	Install Box Inlet & Culvert (Grade Stab. Str. S-1D)	280
Main No. 2	5+44	Farm Drive - Sec. 12, T146N, R49W	Replace Culvert	300
	40+46	Sec. 1, 6, 7 & 12, T146N, R49/48W	Replace Culvert	280
	44+38	Field Drive - Sec. 6, T146N, R48W	Remove (Culvert)	
	89+01	BN-RR Trestle, Sec. 7, T146N, R48W	Satisfactory	
	91+83	U.S. Hwy. 75, Sec. 5, 6, 7, 8, T146N, R48W	Satisfactory	
	144+29	Sec. 4, 5, 8 & 9, T146N, R48W	Replace Culvert	220

TABLE 3B - Structure Data (Continued) - 3

Channel	Station	Location	Effect	Reg'd 1/ Capacity (cfs)
Main No. 2	171+21	Field Drive - Sec. 4, T146N, R48W	Replace Culvert	220
	197+59	Sec. 3, 4, 9 & 10, T146N, R48W	Replace Culvert	185
	250+22	Sec. 2, 3, 10 & 11, T146N, R48W	Replace Culvert	150
	302+63	Sec. 1, 2, 11, & 12, T146N, R48W	Satisfactory	
	324+79	Farm Drive - Sec. 12, T146N, R48W	Remove	
	335+31	Farm Drive - Sec. 12, T146N, R48W	Remove	

1/ Design based on 50 year freq. discharges

TABLE 4 - ANNUAL COST

Norman-Polk Watershed, Minnesota

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total Cost
Main No. 1 Channel Work and Grade Stabilization Structures S-1, S-1A, S-1B, S-1C, and S-1D Main No. 2 Channel Work and Grade Stabilization Structure S-2	82,310	22,150	104,460
Project Administration	9,890		9,890
GRAND TOTAL	92,200	22,150	114,350

1/ Price Base, Installation - 1973, O&M Adjusted Normalized.

2/ Amortized for 50 years at 5-3/8 percent interest.

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Norman-Polk Watershed, Minnesota

(Dollars)[1/]

Item	Estimated Average Annual Damage[2/]		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop	141,600	59,950	81,650
Crop (off Project) [3/]	3,840	1,230	2,610
Other Agricultural	8,230	2,160	6,070
Other Agricultural (off project)	230	40	190
Nonagricultural Road and Bridges	2,080	1,140	940
Subtotal	151,910	63,250	88,660
Subtotal (off project)	4,070	1,270	2,800
Erosion [4/]			
Streambank	13,900	1,070	12,830
Indirect	16,680	6,490	10,190
Indirect (off project)	410	130	280
Total	182,490	70,810	111,680
Total (off project)	4,480	1,400	3,080

1/ Price base - Adjusted Normalized.
2/ Includes flood damages which will be affected by the structural measures included in the Work Plan.
3/ Damages and benefits evaluated outside watershed boundaries.
4/ Includes only the damages and benefits occurring from voiding or land deterioration affected by streambank protection measures.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Norman-Polk Watershed, Minnesota

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/						Average Annual 2/ Cost	Benefit Cost Ratio
	Damage Reduction	More Intensive Land Use	Drainage	Redevelop-ment	Secondary	Total		
Main No. 1 Channel Work and Grade Stabilization Structures S-1, S-1A, S-1B, S-1C, and S-1D Main No. 2 Channel Work and Grade Stabilization Structure S-2	111,830	11,450	14,170	9,250	16,600	163,300	104,460	1.6:1
Project Administration							9,890	
GRAND TOTAL	111,830 3/	11,450	14,170	9,250	16,600	163,300	114,350	1.4:1

1/ Price base - Adjusted Normalized.

2/ From Table 4.

3/ In addition, land treatment measures are estimated to provide flood damage reduction benefits of $2,930 annually.

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TABLE 7 - CONSTRUCTION UNITS

Norman-Polk Watershed, Minnesota

(Dollars) 1/

Measures in Construction Unit	Annual Benefit	Annual Cost
Construction Unit No. 1	147,570	90,890
Channel Work Main No. 1, Branch 1, Branch 2 Grade Stabilization Structures S-1, S-1A, S-1B, S-1C & S-1D		
Construction Unit No. 2 2/	163,300	114,350
Channel Work Main No. 2		
Grade Stabilization Structure S-2		

1/ Price base, construction cost, 1973 prices. Benefits and Operation and Maintenance, Adjusted Normalized.

2/ Construction Unit No. 2 is contingent upon the installation of Construction Unit No. 1.

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INVESTIGATIONS AND ANALYSES

Hydraulics and Hydrology

Due to the lack of definite flood flow patterns in the watershed, no attempt was made to determine area flooded by use of valley cross sections flood routing. The net income method was used for evaluation of the project.

Water surface profiles were developed for all existing channels where channel improvement is planned. The profiles were developed using surveyed channel cross sections, which were located approximately ¼ mile apart. The effect of bridges and culverts was considered in developing the water surface profiles.

From the water surface profiles, the capacity of the existing channels at the designed water surface of the planned channels was determined for all reaches of channel improvement. This capacity was used to determine the frequency of flood that the existing channels would carry. The existing channels were determined to provide approximately a 1-year-frequency flood protection. The improved channels were designed to provide a 5-year-frequency level of protection. Since flooding occurs on the average of once every year under present conditions, and will occur on the average of once every 5 years with the project in effect, the project will reduce the occurrence of flooding by 80 percent. This percent reduction in flood occurrence was considered in arriving at the percent reduction in damage used for evaluation of the project.

Discharge-frequency was based on drainage area-discharge curves developed by the Minnesota Highway Department. These curves were developed for the 50-year-frequency discharge and are based on stream gage data. Discharge for other frequency floods was based on the ratio of runoff for other frequencies to the 50-year-frequency runoff. Runoff depths, by frequency, were calculated from U.S. Weather Bureau TP-40 rainfall depths by the use of runoff curve numbers.

The basic information for computing runoff curve numbers was taken from a 5 percent random sample of quarter sections of land.

To select a method of computing the discharge capacity for channel designs, comparisons were made between Meyers Curves, Minnesota Drainage Curves, and curves developed by the SCS in North Dakota. Minnesota Drainage Curve No. 2 was selected because it compares to a five-year-frequency Minnesota Highway Curve and a 6-year-frequency curve from the SCS in North Dakota.

The local sponsors desired approximately a 5-year-frequency level of protection. Design discharge for bridges, culverts, and the stabilization structures was based on the 50-year frequency Minnesota Highway Department Curves. A factor of K equal to 130 was selected as a conservative estimate of the hydrologic conditions in the watershed. The 20-40 rule was used where applicable for adjusting the design discharges.

Engineering

A bench level circuit was completed in the channel and structure areas of the watershed, which were closed within the allowable error of third-order leveling. The survey is based on mean sea level datum. Stadia profile surveys were made on the channels with channel cross sections approximately every ¼ mile. If channel irregularity demanded, cross sections were taken at closer intervals. Dimensional data was obtained for all bridges and culverts and other items such as utilities, farmsteads, pipelines, etc., pertinent to planning. A topographic map with 5-foot contours was made for the retarding structure proposed at the upper end of main No. 1. Three topography maps were made for the gullied areas for the three mains which outlet into the Red River of the North.

Engineering Memorandum 72, "Channels and Floodways", Technical Release No. 25, and current SCS standards were the design criteria used in planning the channels and their appurtenances. Each reach has been designed for the most critical combination of factors involved to insure stability of the structural measures. All bridges and culverts were planned in accordance with Minnesota Highway design criteria.

The allowable design velocities for the channels range from 2.5 feet per second in the beach ridges, to 4.5 feet per second in the remaining area. On main No. 1, branch 2, a 20 percent increase in allowable velocity was used for design purposes in accordance with State Engineering Specification MN-582. The allowable velocity by reaches is shown in Table 3.

The "n" value for "aged" condition is 0.035 and for "as-built" is 0.025. An excellent growth of grass is expected in this area with existing soil conditions.

additional berm will be used along the channel slopes, where necessary, to prevent bank sloughing.

Main No. 1 and Branches 1 and 2

Main No. 1 and branch 1 and 2 drain the northern portion of the watershed. The local people requested improvements for this area. See Project Map for location.

The soils for this improvement are largely massive CH lake clays, but will also include glacial lake offshore fine silty sands and sandy beach ridge deposits.

Main No. 1 and branches 1 and 2 are enlargement of existing judicial ditches and road ditches to give a 5-year frequency level of protection. The hydraulic gradient is designed for the same elevation as the low points in the field which are often ½ mile or more from the channel. The spoil banks will be shaped and seeded as shown on the typical cross section, Figure 6.

All surface inlets to the channels, except large drainage areas, are planned to be pipes through the spoil bank. The pipes will be gated where this is necessary.

Main No. 1 outlets into the Red River of the North. The drop in elevation is about 30 feet from the channel bottom to the river bottom. The present channel angles northwest for about ½ mile before it enters the river. There is a large gully from the river and upstream to U.S. Highway No. 75. The improvements for this reach entail channel realignment, backfilling the gully to grade, and shaping side slopes. Clay material, that will be designed with an allowable velocity of 4.5 feet per second, will be used to fill the existing gully.

The foundation materials, through the present channel reach that angles northwest, are not suitable for supporting the outlet structure. Therefore, it was decided to align the improvement due west to the river through more stable soils that will support the concrete chute grade stabilization structure, S-1, needed for this outlet.

S-1A, located about ½-mile upstream of the outlet, is a combination bridge and grade stabilization structure planned as a box inlet drop spillway.

A straight drop structure is planned to be constructed on the entrance to the twin box culvert at U.S. Highway No. 75 to provide grade stability at the cemetery. The newly-constructed retaining wall at the cemetery is satisfactory. It is believed best to slow the water as much as possible since the channel is irregular at this reach.

A straight drop spillway grade stabilization structure is planned approximately 2,000 feet below the upper limit of main No. 1.

A box inlet to culvert, S-1D, is planned for the upper limits of branch 2 at State Highway No. 9.

Branch 2 is routed to avoid crossing a gas pipeline which is too shallow for the channel to pass over it. Lowering the pipeline would be very costly.

A few bridges are adequate to pass the bridge design flows, a number have to be replaced to meet design criteria. The local people have selected a number of bridges that will be removed and not replaced because of infrequent use. The affected roads will be closed.

A retarding structure was studied at the upper limit of main No. 1 in section 34, T. 147 N., R. 46 W. It is a poor site. The dam would have to be 1 mile or more long requiring a great amount of fill. The storage area is flat, not well-defined and would need a large pool area. About 17 square miles would be controlled by the retarding structure providing fair reduction immediately below the structure. However, branch 2 enters the main three miles downstream with a large uncontrolled area and from there the structure has little effect.

Main No. 2

Main No. 2 drains about 6.5 square miles in the western part of the watershed. The improvement was requested by the local people. See Project Map for location.

The soils for this improvement are largely massive CH lake clays.

The improvement is enlargement of the existing judicial ditch 54, lateral 1, to give a 5-year-frequency level of protection. The hydraulic gradient is designed for the same elevation as the low points in the field. The spoil banks will be shaped and seeded as shown on the typical cross section, Figure 6.

The surface inlets to the channel are planned to be pipes through the spoil bank. The pipes will be gated where necessary.

Main No. 2 outlets into the Red River of the North. The drop in elevation from the channel bottom to the river bottom is about 30 feet. Therefore, a concrete chute grade stabilization structure, S-2, is planned for this outlet.

A few bridges and culverts are adequate to pass the bridge and culvert design flows, and a few had to be replaced to meet design criteria.

Judicial Ditch 54 and County Ditch 3 with County Ditch 28 as a Branch

These channels drain about eight square miles in the western part of the watershed. The local people requested improvements in this area. See the existing Water Development Map for location.

Judicial Ditch 54 and County Ditch 3, as well as County Ditch 28, were surveyed. No design was made, however, because the local people are improving the channels without federal assistance.

Judicial Ditch 53 and Branches

This channel drains the southern portion of the watershed and was studied as main No. 3. The local people requested improvements for this area but it was dropped from the plan because it could not be economically justified.

See the existing Water Development Map for location.

The channel was planned to give a 5-year frequency level of protection. This involved a small degree of enlargement of the present channel. The channel was designed with 4:1 side slopes. A grade stabilization structure was planned for the outlet, which would control the drop of about 25 feet into the Marsh River. Drop inlets with gates were also planned for the channel to remove the surface water. A number of bridges needed replacement.

Land Use and Treatment

Present land treatment adequacy and future land treatment needs were estimated by selecting a 5 percent random sample of quarter sections in each of the major land resource areas within the watershed. These sample areas were studied to determine land use by the various land capability units and expanded to cover the entire watershed. In consultation with local soil conservation personnel, adequate land treatment practices were established for each land capability class and land use. The sum of these practices determined the total amount of soil and water conservation practices needed to adequately protect and improve the soil resources on the watershed. The amount of applied practices was obtained from Soil Conservation Service work unit records. The amount of practices to be applied in the project period was determined from the expected participation by the landowners and operators, and the remaining job to be done. The needed practices were expressed as acres to be adequately treated, considering the alternative practices which could be used to protect land of various capability classes. Soil loss was based on the Universal Soil Loss Equation. Studies and evaluation of forest treatment needs were made by the U.S. Forest Service using hydrologic data, soil information, and comprehensive river basin source data. Information on the forest conditions, problems, and treatment needs were also determined by the state district forester in consultation with local residents.

A treatment program for forest land and adjacent environments was recommended on 70 acres. With the installation of these forest treatment measures, it is estimated that about 70 percent of the woodlands and surrounding area will be adequately treated.

There were no recorded forest fires in the watershed during the past 5 years. The present degree of rural fire protection is considered adequate, and no increased hazards are anticipated as a result of the watershed program.

Economic Investigations

The net income method of analysis was used in the economic evaluation of this watershed project.

The basic data used in the economic evaluation of agricultural damage was obtained from field interviews with local farmers. Information was obtained on (1) extent of flood plain, (2) land use, (3) crop distribution, (4) present yields, (5) without project yields, (6) with project yields to reflect the potential of the farm with present level of management, (7) cultural practices, (8) historical information on flooding and flood damages, and (9) other damages, such as erosion, sediment, fences, etc. This data was summarized and then reviewed with local technicians and farmer leaders to make needed adjustment. Analysis of other similar watershed projects also formed a basis for determining damage rates.

The without project yields for the major crops were developed from interviews with farmers to reflect the reduced yields experienced from a delay in seeding and flood damage caused by snowmelt runoff and subsequent dryout time as well as summer floods. Composite acre values were drawn for each crop and net return was calculated for the conditions that will exist, with and without project. The cost of agricultural operations, and prices received for agricultural products, were adjusted to reflect adjusted normalized prices. The composite acre percentages of each crop were held the same for without and with project considerations.

After studying maps, making field reconnaissance, and interviewing landowners, it was found that this watershed was comparable with nearby watersheds on which detailed hydraulic and hydrologic information was developed.

It was determined that 63 percent of the maximum damaged area is being damaged by floodwaters on an average annual basis.

The without project crop damage value was calculated by multiplying the acres subject to average annual flooding by the increase in net income per acre that is expected under flood-free conditions. The damages will be reduced 70 percent as a result

of applying the land treatment measures and installing the structural measures.

The 70 percent reduction factor was developed from coordination studies made on other projects that had been designed with 5-year-frequency level of protection. Greatest emphasis was placed on projects that are located in the Red River Valley. Projects in the North Dakota portion of the valley were also included in the determination of the damage reduction factor.

Accrual of benefits from cropland use and drainage are partly dependent on the installation of ditch mains, laterals, and field ditches. These costs amounting to $10,800 annually were treated as associated cost and subtracted from the benefits. These benefits have been discounted for 10 years (5-3/8 percent interest) to allow for these measures to be installed. The local people's cost of construction for on-farm drainage in the benefited area is $110,000. Small depressional areas of cropland are dispersed throughout the flood plain area. These areas sustain damages from both floodwater inundation and prolonged wetness, thus necessitating a dual-purpose flood prevention and drainage channel for the depressional areas involved. The amount of depressional areas was determined for each soil type by the soil scientists. These values were applied to the soils in the benefited area using available soil survey maps.

Depressional areas within the benefited area amounted to 9,600 acres or 20 percent of the area served by the proposed structural measures. The 20 percent value was allocated equally to flood prevention and drainage. Therefore, 10 percent of the total installation cost of the structural measures was allocated to drainage and the remaining 90 percent to flood prevention.

Analysis of the land treatment data showed that 4,000 of the 9,600 acres of depressions within the area, served by the channel improvement, lacked proper field outlets needed for the construction of on-farm surface drainage systems. For this area, benefits from the increase in net income per acre were divided equally between flood prevention and drainage. The benefit from drainage was considered occurring annually while the benefits from flood prevention were adjusted to an average annual value to properly weigh all flood events.

Other agricultural damages include the loss of stored grain, damages to farm buildings and machinery, and extra cultural practices to control noxious weed infestations brought in by the floodwater. These damages were determined from interviews and converted in a damage value per flooded acre.

Damages to roads and bridges were obtained from interviews, and by estimating the damages that occur from various storm frequencies for each bridge and section of road from floodwaters.

Land damages were computed according to the procedures, outlined in Chapter 5 of the Economics Guide, for the expected voided areas. Damage reduction benefits to roads, culverts, utilities, and bridges, from the installation of the grade stabilizing structures and channel improvement, were obtained by determining the savings gained by prevention of the replacement costs. Replacement cost values were lagged to the time that replacement is expected.

The indirect damages are associated with the floodwater damages. They represent the inconvenience and unevaluated costs which accompany these damages. They are calculated as 10 percent of the average annual agricultural damages and 15 percent of the average annual road and bridge damages for both with project and without project.

Areas benefited by more intensive use were considered to be the same area as benefited by flood prevention. The benefits were based on the increased net income to be obtained from the expected increase in yields on present cropland areas.

Secondary benefits, from the installation of project measures in this watershed, will result in increased income to processors of agricultural products, to business establishments in towns and trade areas affected, and to individuals other than the direct identifiable beneficiaries. These benefits were determined to be 10 percent of the following: direct primary benefits, increased cost of more intensive land use, and of the operation and maintenance costs. These benefits were not used for economic justification, but were included in the final benefit-cost analysis.

Prices received and paid by farmers are "adjusted normalized prices" obtained from the Interim Price Standards for Planning and Evaluating Water and Land Resources, Interdepartmental Staff Committee of the Water Resource Council, dated April, 1966. The operation and maintenance cost of structural measures are based on 1973 prices converted to adjusted normalized prices. Installation costs were calculated on the current 1973 price base.

The value of land rights, used for cost estimating, are based upon the values set by appraisers on similar land areas in this area of the state.

In converting project costs to an annual basis, a 5-3/8 percent interest rate for the 50-year project period was used. In converting private associated costs to an annual basis, a 6 percent interest rate was used.

Geologic Investigations

Channel Investigations

Channel stability reports with recommendations were prepared for each channel system, judicial ditch 52 (main No. 1), judicial ditch 54, lateral 1, (main No. 2) and judicial ditch 53 (main No. 3). A study was made of present channel conditions in order to correlate present channel behavior with the geologic materials through which they pass, and to provide work plan design criteria that will reasonably accommodate the existing geology.

Approximately 50 miles of proposed channels were investigated. Thirty soil borings were secured. Hydraulic data on present channels was used to evaluate erosion and sedimentation conditions.

The channel systems traverse various geologic deposits including glacial Lake Agassiz massive CH lake clays, varved (layered) lake clays and silts, glacial lake offshore fine silty sands, and sandy beach ridge deposits. Samples of these various types of deposits were secured and Atterberg limit tests and sand sieve analysis were run on the samples. The non-scour velocities for these materials were determined according to SCS Technical Release No. 25 and are included in the geologic report and are shown in Table 3.

Channel Velocity Recommendations for Work Plan Cost Estimates

Massive Stiff CH Lake Clay

The allowable velocities of these soils as determined according to SCS Technical release No. 25 using Atterberg limit test data are 4.5 feet per second. These materials will withstand much higher velocities without appreciable erosion for short periods.

Varved Lake Silts - ML and Clayey Silts MH.

These materials are suspected to be the cause of bank sloughing in the channel reaches that exceed a depth of 10 feet. The position of these deposits in the channel bank is critical as regards sloughing. The channel velocities, as determined in accordance with SCS Technical Release No. 25 from Atterberg limit tests, are 3.5 with some as low as 2.5. However, downcutting in these materials will not be rapid, and the materials could withstand velocities up to 4.5 feet/second for short periods, as during the period of construction.

Beach and Off-Shore Sand Bar Deposits

These are very erosive deposits. The channel velocities as determined in accordance with SCS Technical Release No. 25 from sand sieve analysis samples, are less than 2.0 feet/second. Excessive velocities even for a short duration will produce severe erosion in these materials.

Concrete Chute Spillway Foundation Investigations

Three sites, S-1, S-2, and S-3, were investigated. Standard penetration tests were performed at each site supplemented by flight power auger borings. Site S-1 was moved due to poor foundation conditions. Geologic information was extrapolated from Site S-2 to the present location.

Gully Erosion Damage Evaluation - Main 1 and 2

The areas that would be voided were determined by projecting historical rates of voiding as determined by comparing engineering survey data from previous surveys.

The limits of channel trenching and bank sloughing were determined by projecting historical rates, as adjusted by developing a limiting channel profile (graded channel), based on gradients determined by the non-erosive velocities of the various materials through which the projected channel will cut in the future.

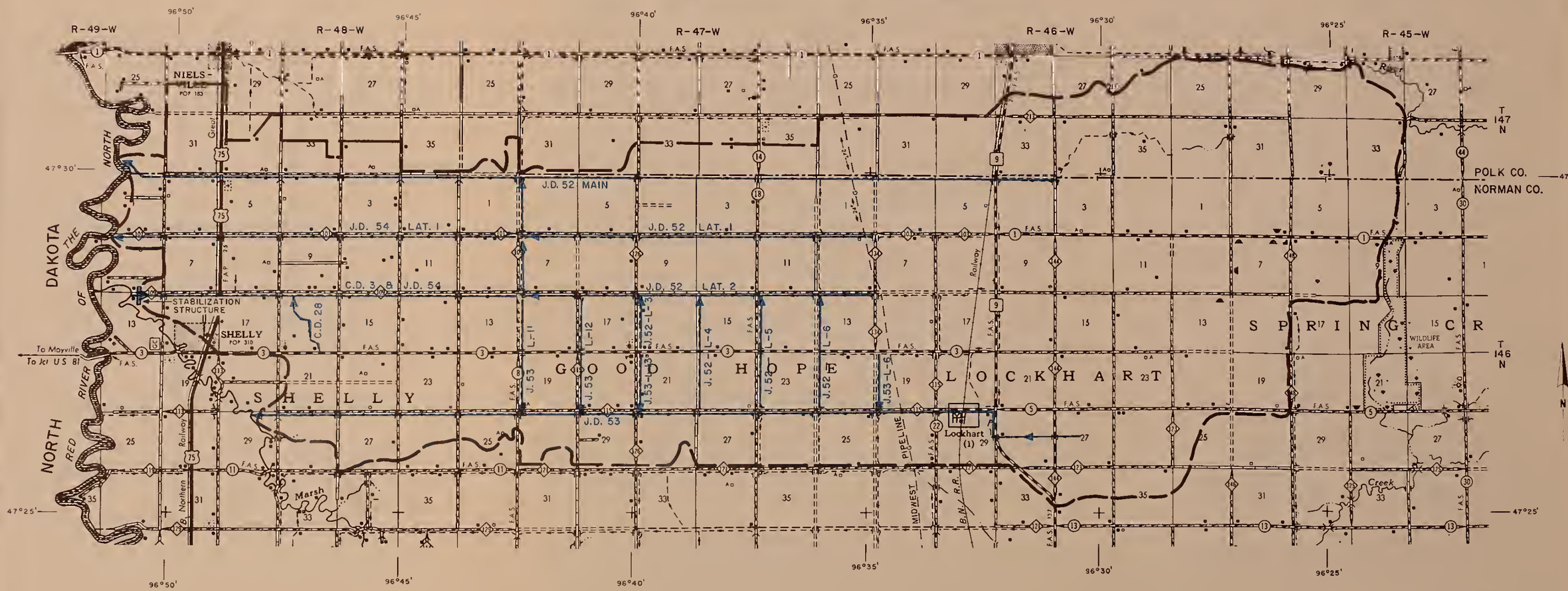
Sediment Yields from Mains No. 1 and 2 Gully Erosion

The sediment yield to the Red River was calculated from comparison of cross sections from previous engineering surveys. A delivery ratio of 100 percent to the Red River was assumed, due to the proximity to the Red River and confinement of the 100-year frequency flood within the entrenched channel section west of U.S. Highway No. 75.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

WATER DEVELOPMENT PROJECT MAP
NORMAN-POLK WATERSHED
NORMAN AND POLK COUNTIES, MINNESOTA



SOURCE:
COUNTY HIGHWAY MAPS AND DATA
FURNISHED BY FIELD TECHNICIANS

USDA SCS-LINCOLN NEBR 1971

(POLYCONIC PROJECTION)

11-8-71
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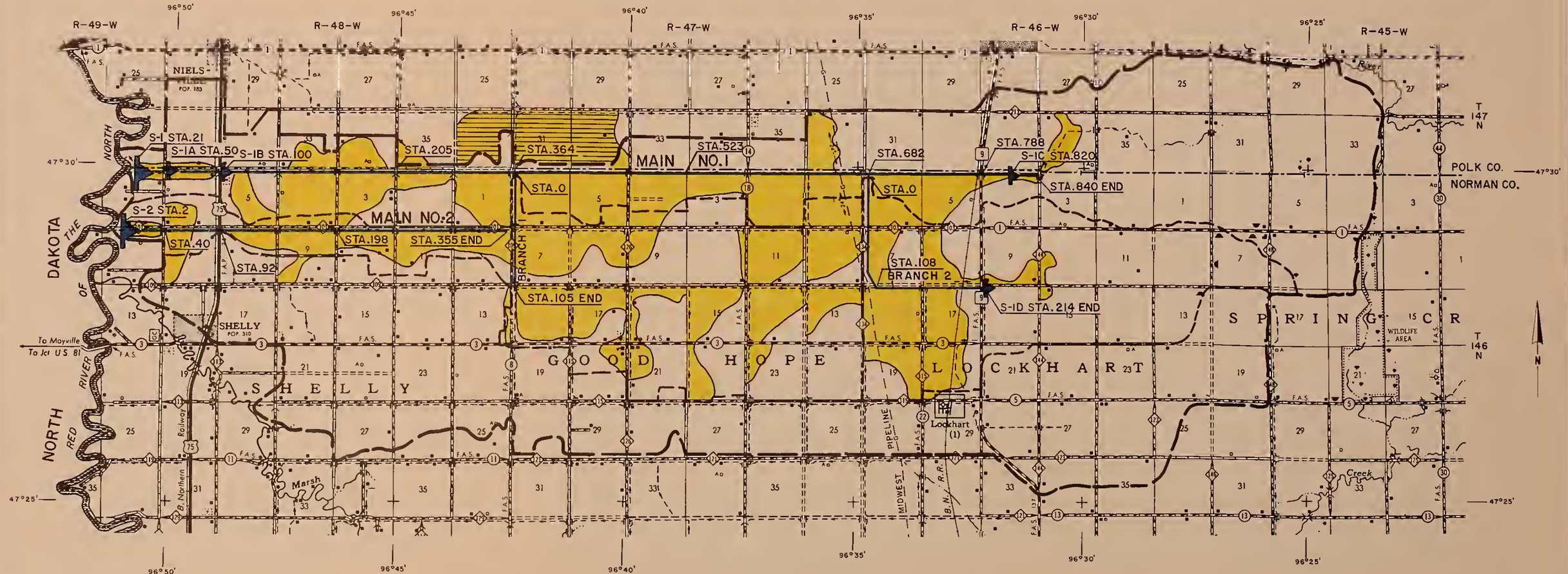
U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

PROJECT MAP
NORMAN-POLK WATERSHED
NORMAN AND POLK COUNTIES, MINNESOTA



LEGEND

WATERSHED BDUNDARY
SUBWATERSHED BDUNDARY

AREA BENEFITED

COMMDN FLDDD PLAIN BENEFITED

GRADE STABILIZATIDN STRUCTURE (CHUTE SPILLWAY)

GRADE STABILIZATIDN STRUCTURE (DRDP SPILLWAY)

CHANNEL IMPRDVEMENT

SCALE 1 0 1 2 3 MILES

SCALE 1/100,000

SOURCE:
COUNTY HIGHWAY MAPS AND DATA FURNISHED BY FIELD TECHNICIANS

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